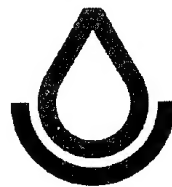
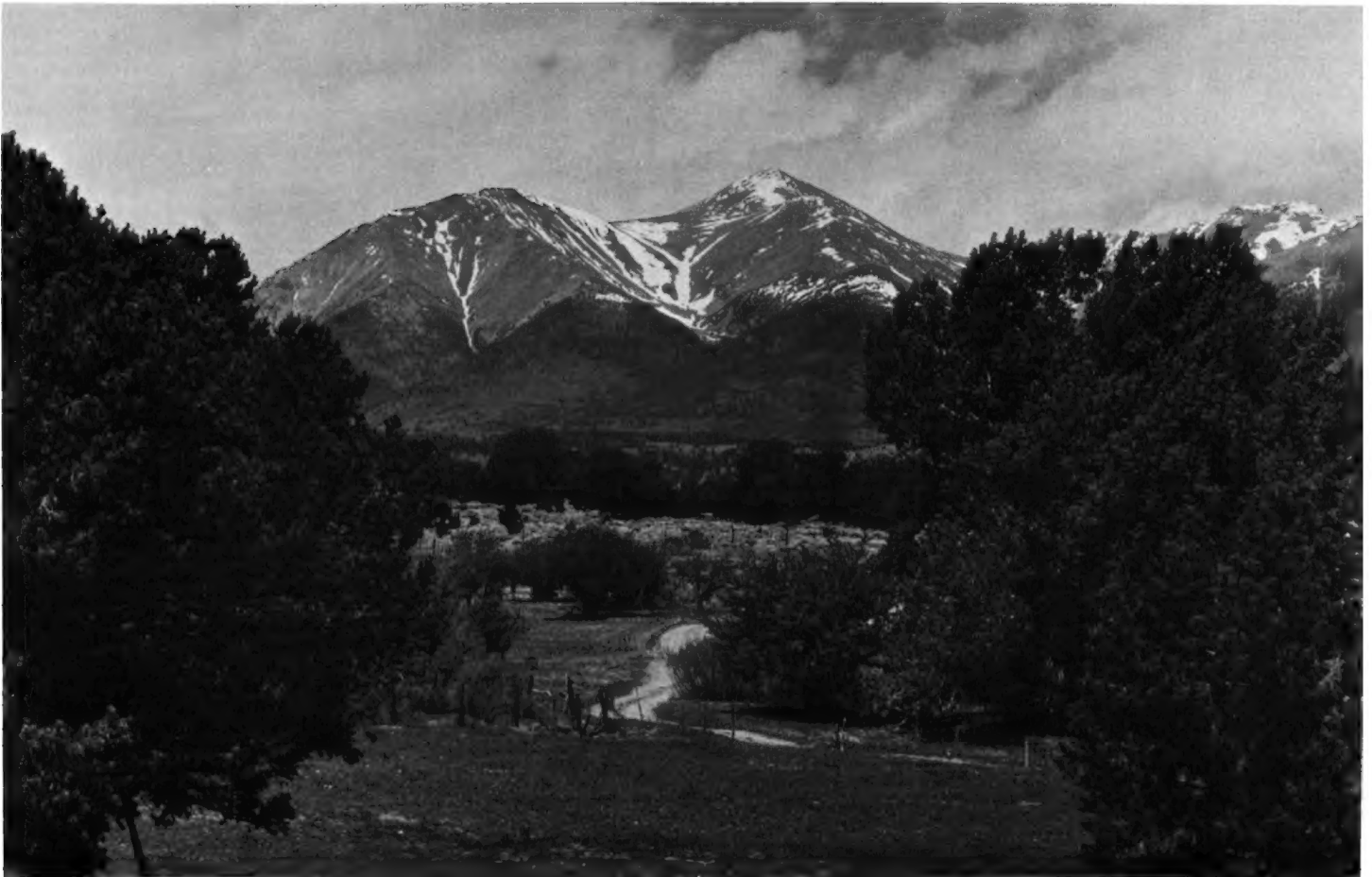


SOIL SURVEY OF

# Chaffee-Lake Area, Colorado

Parts of Chaffee and Lake Counties



United States Department of Agriculture  
Soil Conservation Service  
In cooperation with  
Colorado Agricultural Experiment Station

Major fieldwork for this soil survey was done in 1965. Soil names and descriptions were approved in 1968. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1965. This survey was made cooperatively by the Soil Conservation Service and the Colorado Agricultural Experiment Station. It is part of the technical assistance furnished to the Upper Arkansas and Lake County Soil Conservation Districts.

Copies of the soil map in this publication can be made by commercial photographers, or they can be purchased on individual order from the Cartographic Division, Soil Conservation Service, United States Department of Agriculture, Washington, D.C. 20250.

## HOW TO USE THIS SOIL SURVEY

**T**HIS SOIL SURVEY contains information that can be applied in managing farms, ranches, and woodlands; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

### Locating Soils

All the soils of the Chaffee-Lake Area, Parts of Chaffee and Lake Counties, are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

### Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the county in alphabetic order by map symbol and gives the capability classification of each. It also shows the page where each soil is described and the page for the capability unit and the range site in which the soil has been placed.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used

as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

*Farmers and those who work with farmers* can learn about use and management of the soils from the soil descriptions and from the discussions of the capability units, the range sites, and the woodland groups.

*Foresters and others* can refer to the section "Woodland and Windbreaks", where the soils of the county are grouped according to their suitability for trees.

*Game managers, sportsmen, and others* can find information about soils and wildlife in the section "Wildlife."

*Ranchers and others* can find, under "Range," groupings of the soils according to their suitability for range, and also the names of many of the plants that grow on each range site.

*Engineers and builders* can find, under "Engineering Uses of the Soils," tables that contain estimates of soil properties and information about soil features that affect engineering practices.

*Scientists and others* can read about how the soils formed and how they are classified in the section "Formation and Classification of the Soils."

Newcomers in the Chaffee-Lake Area may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the survey area given in the section "General Nature of the Survey Area."

**Cover:** Mt. Shavano located just west of the survey area. The "Angel of Shavano," in snow, is good indication of the rate of snow melt and quantity of water available for irrigation.

## Contents

	Page		Page
<b>How this survey was made</b> .....	1		
<b>General soil map</b> .....	3	Rosane series .....	26
Soils of the mountains .....	3	Rough broken land .....	26
1. Rock outcrop-Bross association .....	3	Rough broken land, cold .....	26
2. Troutville-Leadville association .....	4	St. Elmo series .....	27
3. Rock land-Rock outcrop association .....	4	San Isabel series .....	27
Soils of the high terraces .....	4	Sawatch series .....	28
4. St. Elmo-Manhattan association .....	5	Shrine series .....	28
5. Dominson-San Isabel association .....	5	Slickens .....	29
6. Cotopaxi-Ouray association .....	5	Stecum series .....	30
7. Pierian-Poncha association .....	6	Tigiwon series .....	30
8. Rough broken land-Badland association .....	6	Tomichi series .....	31
Soils of the terraces and bottom lands .....	7	Troutville series .....	31
9. Wet alluvial land-Gas Creek association .....	7	Turret series .....	32
10. Newfork-Marsh-Rosane association .....	7	Wet alluvial land .....	32
<b>Descriptions of the soils</b> .....	7	<b>Use and management of the soils</b> .....	33
Adilis series .....	8	Capability grouping .....	33
Antero series .....	9	Management of irrigated soils .....	34
Badland .....	10	Predicted yields .....	37
Blanyon series .....	10	Management of nonirrigated soils .....	37
Bross series .....	11	Range .....	40
Cabin series .....	11	Range management practices .....	40
Chaffee series .....	12	Range sites and range condition .....	41
Collegiate series .....	12	Woodland and windbreaks .....	43
Costilla series .....	13	Forest-cover types .....	43
Cotopaxi series .....	13	Woodland suitability groups .....	44
Dominson series .....	14	Windbreaks .....	45
Gas Creek series .....	15	Wildlife .....	45
Granile series .....	16	Engineering uses of the soils .....	47
Grantsdale series .....	16	Engineering soil classification systems .....	47
Gravelly alluvial land .....	17	Soil properties significant to engineering .....	54
Hawksell series .....	17	Engineering interpretations of soils .....	54
Keeldar series .....	17	<b>Formation and classification of the soils</b> .....	55
Leadville series .....	18	Factors of soil formation .....	55
Manhattan series .....	19	Climate .....	66
Marsh .....	20	Living organisms .....	67
Mine pits and dumps .....	20	Time .....	68
Newfork series .....	20	Relief .....	69
Ouray series .....	21	Parent materials .....	69
Ouray series, thick surface variant .....	21	Classification of the soils .....	70
Pando series .....	22	<b>General nature of the survey area</b> .....	72
Peat .....	23	History .....	72
Pierian series .....	23	Climate .....	72
Placer diggings and tailings .....	23	Physiography .....	73
Poncha series .....	23	Geology .....	74
Rock land .....	24	<b>Literature cited</b> .....	75
Rock outcrop .....	24	<b>Glossary</b> .....	75
Rock slides .....	25	<b>Guide to mapping units</b> .....	Following





# SOIL SURVEY OF CHAFFEE-LAKE AREA, COLORADO

## PARTS OF CHAFFEE AND LAKE COUNTIES

BY LOUIS A. FLETCHER

FIELDWORK BY ERNEST L. WESSWICK, IN CHARGE, JERRY B. HARMAN, AND RODNEY E. PREATOR, SOIL CONSERVATION SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE

UNITED STATES DEPARTMENT OF AGRICULTURE IN COOPERATION WITH  
COLORADO AGRICULTURAL EXPERIMENT STATION

**C**HAFFEE-LAKE AREA, Parts of Chaffee and Lake Counties, is just west of the geographical center of the State of Colorado (fig. 1). Approximately

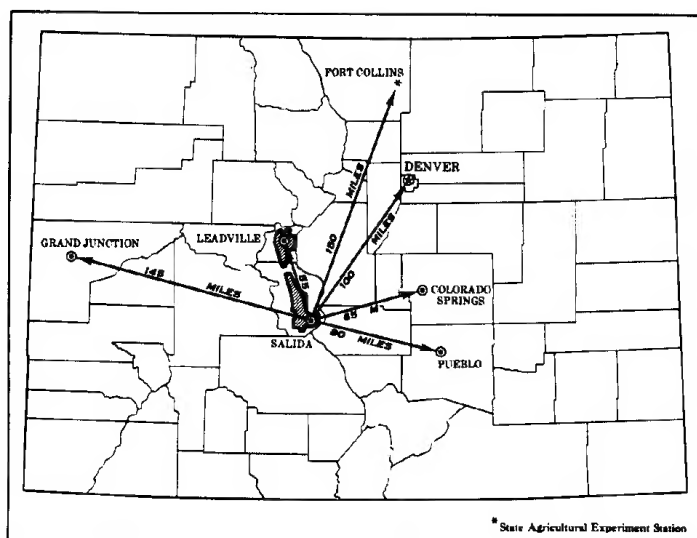


Figure 1.—Location of Chaffee-Lake Area in Colorado.

two-thirds of the survey area is in Chaffee County, of which Salida is the county seat. The rest of the survey area is in Lake County, of which Leadville is the county seat. There are 226,560 acres, or 354 square miles, in the survey area. It consists of narrow, high-mountain valleys of the Arkansas River and is surrounded by rough mountainous topography that is characterized by many steep slopes, narrow canyons, and high mountains. To the west is the Continental Divide, characterized by many high mountains, several of which are more than 14,000 feet high. Mt. Elbert, at an elevation of 14,431 feet, is the highest.

The survey area extends approximately 63 miles north and south and varies in width from one-half mile to 15 miles. The boundary coincides with that of the national forest, and most of the area is within the

valleys. The area takes in the headwaters of the Arkansas River, which is the main drainageway and flows from north to south through the central part of the area (fig. 2). The main tributaries of the Arkansas River in Chaffee County are, from the west, the South Arkansas River, whose tributaries are Poncha and Cochetopa Creeks, and the Chalk, Cottonwood, and Lake Creeks; from the northeast, Trout Creek and a number of such minor tributaries as Squaw Creek, Browns Creek, and Clear Creek. The main tributaries of the Arkansas River in Lake County are the East Fork of the Arkansas River, Tennessee Creek, Lake Fork Creek, Willow Creek, and Half Moon Creek. There are also several lakes and reservoirs scattered throughout the area.

In the Chaffee-Lake Area the production of both cattle and sheep is the principal enterprise. In the irrigated areas, alfalfa and native hay are grown for winter feed. Production of these is limited by a short growing season and low annual precipitation. The area has good potential for recreational development.

### *How This Survey Was Made*

Soil scientists made this survey to learn what kinds of soil are in Chaffee-Lake Area, where they are located, and how they can be used. The soil scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes, the size and speed of streams, the kinds of native plants or crops, the kinds of rock, and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and



**Figure 2.**—The Arkansas River, which flows through the survey area, provides water for irrigation and fishing. It is the main municipal water supply.

the *soil phase* are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Gas Creek and Leadville, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other

characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, St. Elmo gravelly sandy loam, 1 to 3 percent slopes, is one of several phases within the St. Elmo series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a map-

ping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. One such kind of mapping unit is shown on the soil map of Chaffee-Lake Area: soil complexes.

A soil complex consists of areas of two or more soils, so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. Generally, the name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Rock land-Stecum complex, 15 to 60 percent slopes, is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, so severely eroded, or so variable that it has not been classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Badland is a land type in this survey area.

While a soil survey is in progress, soil scientists take soil samples needed for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soil in other places are also assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil. Yields under defined management are estimated for all the soils.

Soil scientists observe how soils behave when used as a growing place for native and cultivated plants and as material for structures, foundations for structures, or covering for structures. They relate this behavior to properties of the soils. For example, they observe that filter fields for onsite disposal of sewage fail on a given kind of soil, and they relate this to the slow permeability of the soil or a high water table. They see that streets, road pavements, and foundations for houses are cracked on a named kind of soil and they relate this failure to the high shrink-swell potential of the soil material. Thus, they use observation and knowledge of soil properties, together with available research data, to predict limitations or suitability of soils for present and potential uses.

After data have been collected and tested for the key, or benchmark, soils in a survey area, the soil scientists set up trial groups of soils. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. They then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under current methods of use and management.

## General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in the Chaffee-

Lake Area. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in an area, who want to compare different parts of an area, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area, or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field or for selecting the exact location of a road, building, or other structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The soil associations in this survey area have been grouped into three general kinds of landscapes for broad interpretative purposes. Each of the broad groups and the soil associations in each group are described in the following pages.

## Soils of the Mountains

These soils are on sloping and very steep fans, terraces, ridges, and side slopes of the mountains and include rising areas of rock outcrops. They lie mainly at the higher elevations in Lake County but take in most of the steep area east of the Arkansas River in Chaffee County. These soils make up 37 percent of the survey area.

The vegetation ranges from sparse stands of pinyon pine at the lower elevations to lodgepole pine at the mid elevations and to alpine grasses and forbs above the timberline.

Little use is made of the vegetation produced on these soils, except by wildlife.

### 1. Rock outcrop-Bross association

*Rock outcrops and sloping to steep, deep soils at elevations of 10,000 to 14,000 feet*

This association is on high mountain slopes above timberline. The soils formed mainly in glacial deposits. The vegetation is alpine grasses and forbs. The average annual precipitation is 20 to 30 inches, average annual soil temperature is 30° F., average soil temperature in summer is 42°, and the frost-free season is less than 10 days.

This association makes up about 3 percent of the survey area. About 60 percent of the association is Rock outcrop, 35 percent is Bross soils, and 5 percent is Rock slides.

Rock outcrop consists of rock outcrops in steep and very steep areas that have many sheer bluffs, crags, and talus slides.

Bross soils are sloping to steep. They have a surface layer and subsoil of strongly acid sandy loam that contains gravel and cobbles throughout.

Rock outcrop is chiefly used for recreation and water

supply. Gross soils are used for summer grazing, especially by sheep. Wildlife, mainly deer and elk, use the area for summer range.

## 2. Troutville-Leadville association

*Gently sloping to steep, deep, gravelly soils at elevations of 8,200 to 10,000 feet*

This association is on gently sloping to steep, mountainous topography along both the east and west edges of the survey area throughout Lake County and in the extreme northern part of Chaffee County. The soils formed in glacial outwash and glacial till. The vegetation is mainly lodgepole pine, spruce, and fir; a small part is native grass. The average annual precipitation is 16 to 25 inches, of which more than half falls as snow. The average annual soil temperature is 38° F., and the average soil temperature in summer is 46°. The frost-free season is 10 to 75 days.

This association makes up about 18 percent of the survey area. About 70 percent of the association is Troutville soils, and 10 percent is Leadville soils. Granile, Pierian, Tomichi, and Stecum soils and Rock outcrop make up the remaining 20 percent.

Troutville soils are on mountains. They are deep, well drained, and slightly acid to neutral. They have a surface layer and subsoil of sandy loam that is modified by gravel, cobbles, or stones. Their substratum is stones, gravel, cobbles, and sand.

Leadville soils are on mountains, high terraces, and alluvial fans. They are deep, well drained, and medium acid to neutral. They have a surface layer of sandy loam and a subsoil of clay loam that are modified by cobbles and stones.

Troutville and Leadville soils are mainly under a cover of lodgepole pine, some of which is noncommercial (fig. 3). The soils are used mainly for very limited livestock grazing, food and shelter for wildlife, recreation, and water supply.

## 3. Rock land-Rock outcrop association

*Rock outcrops and steep and very steep, very shallow soils at elevations of 7,000 to 8,500 feet*

This association is on steep and very steep mountain slopes east of the Arkansas River. It extends from the southern limits of the survey area to just south of the Lake County line. The association is mainly outcrops of granite and associated very shallow soils that formed in place in material that weathered from granite. The vegetation is sparse; scrubby pinyon pine is dominant, along with such grasses as blue grama, mountain muhly, and Indian ricegrass. The average annual precipitation is 10 to 15 inches, average annual air temperature is 38° to 46° F., and the frost-free season is 30 to 100 days.

This association makes up about 16 percent of the survey area. About 75 percent of the association is Rock land, about 20 percent is Rock outcrop, and about 5 percent is Stecum soil and Gravelly land.

Rock land is 50 to 90 percent outcrops of granite and 10 to 50 percent very shallow soils. Rock outcrop is 90 percent or more outcrops of granite; the rest is very shallow soil material.

Most of this association is used only for water supply, wildlife habitat, and recreation.

## Soils of the High Terraces

These soils are on nearly level to steep terraces. Drainageways commonly dissect the soils, and some areas are now Rough broken land. These soils occur mainly west of the Arkansas River, but small areas are on the narrow terraces or the east bank of the river. These high-terrace soils make up 52 percent of the survey area.



Figure 3.—Cover of lodgepole pine and a grass understory, typical of Troutville-Leadville association.



The vegetation is chiefly grass, but many field-size areas of the less sloping soils are irrigated for both grain crops and hay.

#### 4. *St. Elmo-Manhattan association*

*Nearly level to steep, deep, well-drained, limy soils*

This association is on nearly level to sloping high terraces and their sloping to steep side slopes in the southern part of Chaffee County. It lies north of U.S. Highway 50 and extends from Salida to Maysville. The soils formed in gravelly alluvium and gravelly and cobbly outwash material. The vegetation is native bunchgrasses or plants used for hay. Elevation ranges from 7,000 to 9,000 feet. The average annual precipitation is 11 to 15 inches. The average annual soil temperature is 46° F., and the average soil temperature in summer is 63°. The frost-free season is 60 to 100 days.

This association makes up about 7 percent of the survey area. About 40 percent of the association is St. Elmo soils, 20 percent is Manhattan soils, and 40 percent is Keeldar, Hawksell, Adilis, Tigiwon, and Turret soils.

St. Elmo soils are calcareous, deep, and well drained. They are nearly level to sloping on terraces and are sloping to steep on terrace breaks. They have a surface layer of gravelly sandy loam that is over gravel, cobbles, and sand at a depth of 20 to 40 inches.

Manhattan soils also are calcareous, deep, and well drained. These soils are on nearly level to sloping terraces. They have a surface layer of sandy loam and gravelly sandy loam. Their underlying material is moderately coarse textured and is over gravel, cobbles, and sand at a depth of 20 to 38 inches.

The nearly level to sloping St. Elmo and Manhattan soils are used mainly for irrigated hay in areas below irrigation ditches (fig. 4). St. Elmo and Manhattan soils are used for livestock grazing in other areas where irrigation water is not available.



Figure 4.—Typical irrigated area of the St. Elmo-Manhattan association. St. Elmo gravelly sandy loam is in the foreground. Manhattan sandy loam is on lower area in the background.

#### 5. *Dominson-San Isabel association*

*Nearly level to steep, deep, somewhat excessively drained soils*

This association is on nearly level to sloping tops of high terraces and their strongly sloping to steep side slopes. It is in the north-central part of Chaffee County, mostly west of the Arkansas River. The terraces are dissected by small perennial and intermittent streams. The soils formed in gravelly outwash materials. The vegetation is bunchgrasses, mainly junegrass, bluegrasses, and Indian ricegrass. Elevation ranges from 7,200 to 8,800 feet. The average annual precipitation is 11 to 16 inches, average annual soil temperature is 46° F., average soil temperature in summer is 64°, and the frost-free season is 75 to 100 days.

This association makes up about 18 percent of the survey area. About 70 percent of the association is Dominson soils, 15 percent is San Isabel soils, and about 15 percent is Pando and Ouray soils and Rough broken land.

Dominson soils are nearly level to sloping on high terrace tops and are strongly sloping to steep on side slopes. They are deep, somewhat excessively drained soils that have a surface layer of gravelly sandy loam. This layer is over gravel, cobbles, and sand at a depth of 8 to 16 inches.

San Isabel soils are stony, nearly level to gently sloping soils on terraces adjacent to the Arkansas River. They are deep, somewhat excessively drained soils that have a surface layer of stony sandy loam and a subsoil of gravelly sandy loam over gravel, cobbles, stones, and boulders at a depth of 10 to 20 inches.

Dominson and San Isabel soils are used mainly for livestock grazing. Some nearly level to gently sloping areas are irrigated and are used mainly to grow alfalfa.

#### 6. *Cotopaxi-Ouray association*

*Nearly level to sloping, deep, well-drained soils*

This association is on nearly level to sloping terraces in the southern part of Chaffee County east of the Arkansas River. The soils formed in alluvium and windblown materials. The vegetation is bunchgrass such as Indian ricegrass and needle-and-thread. Alfalfa and small grains are in the irrigated areas. Elevation ranges from 7,000 to 7,700 feet. The average annual precipitation is 10 to 14 inches, average annual soil temperature is 46° F., average soil temperature in summer is 64°, and the frost-free season is 85 to 110 days.

This association makes up about 3 percent of the survey area. About 65 percent of the association is Cotopaxi soils, 35 percent is Ouray soils, and less than 1 percent is other soils.

Cotopaxi soils are deep and well drained and are in the more steeply sloping parts of the association. They have a surface layer of loamy fine sand that is over fine sand.

Ouray soils are deep and well drained and are in the nearly level to gently sloping areas, generally below the Cotopaxi soils. They have a surface layer of sandy loam that is over sand.

Cotopaxi and Ouray soils are used mainly for live-

stock grazing. Some areas are cultivated; alfalfa and small grains are grown.

#### **7. *Pierian-Poncha association***

*Nearly level to steep, deep, well-drained soils*

This association is on nearly level to steep high terraces in Lake County and in the extreme northern part of Chaffee County, mostly west of the Arkansas River. The soils formed in glacial outwash material and alluvium. The vegetation is cool-season grasses, such as Arizona fescue, needlegrass, and mountain muhly. Elevation ranges from 8,200 to 9,600 feet. The average annual precipitation is 16 to 20 inches, average annual soil temperature is 38° F., average soil temperature in summer is about 53°, and the frost-free season is 25 to 60 days.

This association makes up about 7 percent of the survey area. About 70 percent of the association is Pierian soils, 20 percent is Poncha soils, and about 10

percent is Leadville and Troutville soils, Badland, and Rough broken land, cold.

Pierian soils are on gently sloping to steep terraces and are deep and well drained. They have a surface layer of slightly acid gravelly sandy loam that is over stones, gravel, and cobbles at a depth ranging from 8 to 16 inches.

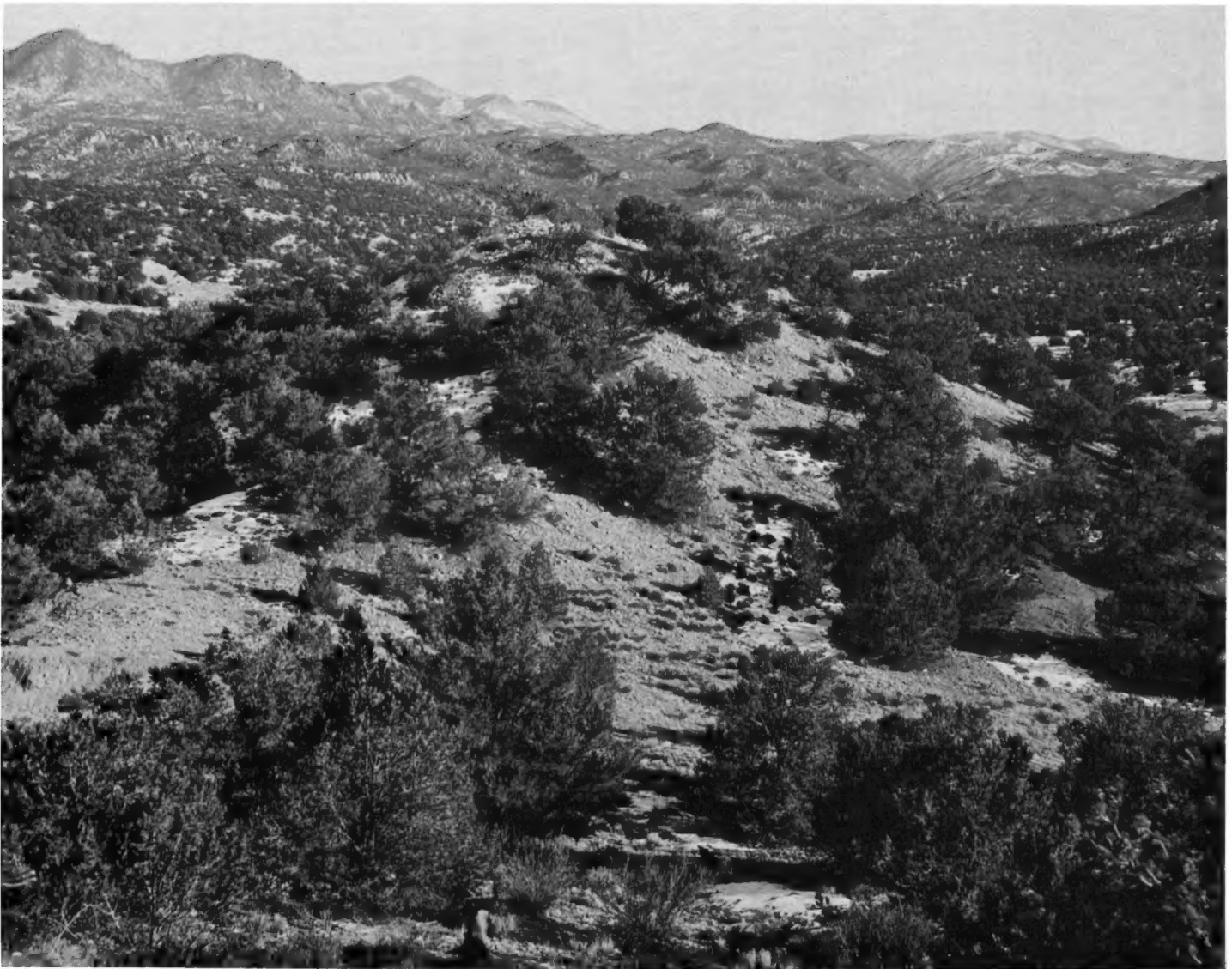
Poncha soils are nearly level to gently sloping on smooth terraces and are deep and well drained. They have a surface layer of neutral gravelly sandy loam that overlies sand, gravel, and cobbles at a depth ranging from 15 to 24 inches.

Pierian and Poncha soils are used mainly for live stock grazing and wildlife.

#### **8. *Rough broken land-Badland association***

*Moderately steep and steep, severely eroded sediments*

This association is on moderately steep to steep, strongly dissected side slopes of terraces and on long



**Figure 5.**—Typical landscape of Rough broken land showing pinyon pine and an understory of grass.

fingerlike protrusions extending onto the valley floor (fig. 5). The association is in the south-central part of Chaffee County west of the Arkansas River. The soil materials are mixed and stratified; they consist of silts and clays in which there are lenses of sand, gravel, and cobbles of the Dry Union Formation. The vegetation is dominantly pinyon pine and grass. Elevation ranges from 7,000 to 8,500 feet. The average annual precipitation is 11 to 15 inches, average annual soil temperature is 45° F., and the frost-free season is 75 to 100 days.

This association makes up about 17 percent of the survey area. About 55 percent of the association is Rough broken land, 30 percent is Badland, and 15 percent is Blanyon, Shrine, Grantsdale, Tigiwon, and Turret soils.

Rough broken land is made up of highly stratified sediments ranging from a few inches to many feet in thickness. Gravel and cobbles cover the surface in most places.

Badland consists of severely eroded, stratified sand, silt, and clay sediments. When rainfall is rapid, a large amount of soil material is washed from this land type because the plant cover is so thin.

Rough broken land is used for livestock grazing and wildlife habitat. Badland is of little use because of the sparse vegetation.

### Soils of the Terraces and Bottom Lands

These soils are on nearly level and gently sloping low terraces, flood plains, and swales adjacent to the Arkansas River and its major tributaries. The soils are poorly drained. They make up about 11 percent of the survey area.

The vegetation is dominantly sedges, willows, and grasses. Many areas, however, have been developed as hayland.

#### 9. *Wet alluvial land-Gas Creek association*

*Nearly level and gently sloping, deep, poorly drained soils*

This association is on low terraces and bottom lands mainly along the Arkansas River, the South Fork of the Arkansas River, Browns Creek, Chalk Creek, Cottonwood Creek, and Gas Creek in Chaffee County. The soils are poorly drained and formed in gravelly alluvium. In irrigated areas the vegetation is grass that is cut for hay. In other areas it is cottonwoods and willows and an understory of grass. Elevation ranges from 7,000 to 8,500 feet. The average annual precipitation is 11 to 15 inches, average annual soil temperature is 46° F., average soil temperature in summer is 64°, and the frost-free season is 75 to 110 days.

This association makes up about 6 percent of the survey area. About 30 percent of the association is Wet alluvial land, 20 percent is Gas Creek soils, and 50 percent is Antero, Chaffee, Collegiate, and Sawatch soils and Peat.

Wet alluvial land is adjacent to the streams on the first bottoms. It consists of gravel and sand bars and wet, stratified, medium-textured and coarse-textured soil materials that are subject to overflow. Gas Creek soils are on the slightly higher terraces. They have a

surface layer of neutral gravelly sandy loam that is over gravelly sand, cobbles, and gravel at a depth of 10 to 18 inches.

Wet alluvial land provides food and shelter for livestock and wildlife. Gas Creek soils are used mainly for irrigated grass, hay, and livestock grazing. The higher areas are used for hay, and the low, wet areas are used for grazing. Cottonwood trees generally grow along streambanks and in sandy, extremely wet areas.

#### 10. *Newfork-Marsh-Rosane association*

*Nearly level and gently sloping, deep, poorly drained soils subject to floods; and marshes*

This association is on low terraces, on bottom lands, and in upland swales, mainly along the Arkansas River, the East Fork of the Arkansas River, Tennessee Creek, Lake Creek, Iowa Gulch, and Half Moon Creek in Lake County. The soils are poorly drained and formed in mixed alluvium. The vegetation is sedges, rushes, willows, and water-tolerant grasses. Elevation ranges from 8,200 to 10,500 feet. The average annual precipitation is 12 to 25 inches, average annual soil temperature is about 36° F., average soil temperature in summer is about 46°, and the frost-free season is 15 to 80 days.

This association makes up about 5 percent of the survey area. About 40 percent of the association is Newfork soils, 30 percent is Marsh, 25 percent is Rosane soils, and 5 percent is Wet alluvial land and Peat.

Newfork soils are on nearly level to gently sloping low terraces. They have a surface layer of gravelly sandy loam that is over gravel, cobbles, and sand at a depth of 10 to 18 inches.

Marsh is in the lowest positions and consists of extremely wet peat underlain by stratified soil materials. It is subject to frequent overflow.

Rosane soils are on nearly level to gently sloping bottom lands and upland swales. They have a 4- to 10-inch organic mat over a surface layer of loam or sandy loam that is 20 to 40 inches thick over sand, gravel, and cobbles. These soils are subject to frequent overflow.

Newfork soils are used mainly for irrigated meadow that is cut for hay (fig. 6). Marsh has little value for grazing and is used chiefly for wildlife habitat. Rosane soils are used mainly for irrigated pasture.

### Descriptions of the Soils

This section describes the soil series and mapping units in the Chaffee-Lake Area. Each soil series is described in detail, and then, briefly, each mapping unit in that series. Unless it is specifically mentioned otherwise, it is to be assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile, that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the



Figure 6.—Typical area of Newfork-Marsh-Rosane association. Hay has been cut on Newfork soils in foreground. Willows cover the Marsh area.

layman. The second is much more detailed and is for those who need to make thorough and precise studies of soils. In the brief description of the profile, the colors given are for the soil when moist. In the more detailed description, however, the colors given are for dry soil unless otherwise noted.

The profile described in the series is representative for mapping units in that series. If the profile of a given mapping unit is different from the one described for the series, these differences are stated in describing the mapping unit, or they are differences that are apparent in the name of the mapping unit.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Badland, for example, does not belong to a soil series but, nevertheless, is listed in alphabetic order along with the soil series.

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit, range site, and woodland group in which the mapping unit has been placed. The page for the description of each capability unit and range site can be learned by referring to the "Guide to Mapping Units" at the back of this survey.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (6).<sup>1</sup>

### Adilis Series

The Adilis series consists of moderately well drained soils on low terraces. These soils are moderately deep to sand, gravel, and cobbles. They formed in gravelly, moderately coarse textured alluvium. Slopes range from 1 to 5 percent. Elevation ranges from 7,000 to 8,200 feet. The plant cover is irrigated grasses. The average annual precipitation is 11 to 15 inches. The average annual soil temperature is 46° F., and the average soil temperature in summer is 62°. The frost-free season is 75 to 100 days.

In a representative profile the surface layer is very dark grayish-brown loam about 4 inches thick. The underlying layer is dark-brown coarse sandy loam and gravelly sandy loam, about 19 inches thick, that is underlain by sand and gravel at a depth of about 23

<sup>1</sup> Italic numbers in parentheses refer to Literature Cited, p. 75.



TABLE 1.—Approximate acreage and proportionate extent of the soils

Soil	Acres	Percent
Adilis loam, 1 to 5 percent slopes.....	1,640	0.7
Antero sandy loam, 1 to 3 percent slopes.....	890	.4
Badland.....	5,180	2.3
Blanyon clay loam, 1 to 3 percent slopes.....	1,120	.5
Bross gravelly sandy loam, 9 to 45 percent slopes.....	3,820	1.7
Cabin gravelly sandy loam, 9 to 25 percent slopes.....	2,740	1.2
Chaffee loam, 1 to 3 percent slopes.....	1,180	.5
Collegiate loam, 1 to 3 percent slopes.....	520	.2
Costilla gravelly sandy loam, 3 to 9 percent slopes.....	700	.3
Cotopaxi loamy sand, 3 to 9 percent slopes.....	4,870	2.1
Dominion gravelly sandy loam, 1 to 9 percent slopes.....	22,880	10.1
Dominion gravelly sandy loam, 9 to 45 percent slopes.....	5,430	2.4
Gas Creek gravelly sandy loam, 1 to 3 percent slopes.....	1,300	.6
Granite gravelly sandy loam, 3 to 35 percent slopes.....	4,470	2.0
Grantsdale fine sandy loam, 3 to 9 percent slopes.....	1,220	.5
Gravelly alluvial land.....	2,440	1.1
Hawksell sandy loam, 5 to 9 percent slopes.....	1,260	.6
Keeldar gravelly sandy loam, 1 to 5 percent slopes.....	1,410	.6
Leadville sandy loam, 3 to 35 percent slopes.....	6,760	3.0
Manhattan sandy loam, 1 to 3 percent slopes.....	460	.2
Manhattan sandy loam, 3 to 9 percent slopes.....	1,940	.9
Marsh.....	3,040	1.3
Mine pits and dumps.....	1,760	.8
Newfork gravelly sandy loam, 1 to 3 percent slopes.....	3,970	1.8
Ouray sandy loam, 1 to 5 percent slopes.....	1,690	.7
Ouray gravelly loam, thick surface variant, 1 to 3 percent slopes.....	990	.4
Pando gravelly sandy loam, 3 to 9 percent slopes.....	3,120	1.4
Peat.....	280	.1
Pierian gravelly sandy loam, 3 to 9 percent slopes.....	4,300	1.9
Pierian soils, 20 to 45 percent slopes.....	5,950	2.6
Placer diggings and tailings.....	690	.3
Poncha gravelly sandy loam, 1 to 5 percent slopes.....	1,360	.6
Rock land, 15 to 60 percent slopes.....	23,850	10.5
Rock land-Gravelly land complex, 3 to 35 percent slopes.....	1,630	.7
Rock land-Stecum complex, 15 to 60 percent slopes.....	760	.3
Rock outcrop.....	20,010	8.8
Rock slides.....	580	.3
Rosane loam, 1 to 5 percent slopes.....	2,580	1.1
Rough broken land.....	20,780	9.2
Rough broken land, cold.....	1,970	.9
St. Elmo gravelly sandy loam, 1 to 3 percent slopes.....	3,370	1.5
St. Elmo gravelly sandy loam, 3 to 9 percent slopes.....	580	.3
St. Elmo gravelly sandy loam, 9 to 45 percent slopes.....	1,970	.9
San Isabel stony sandy loam, 1 to 5 percent slopes.....	5,300	2.3
Sawatch sandy loam, 1 to 5 percent slopes.....	920	.4
Shrine clay loam, 3 to 9 percent slopes.....	1,070	.5
Slickens.....	30	( <sup>1</sup> )
Tigiwon-Turret cobbly sandy loams, 3 to 25 percent slopes.....	6,350	2.8
Tomichi sandy loam, 5 to 25 percent slopes.....	2,610	1.2
Troutville gravelly sandy loam, 3 to 35 percent slopes.....	27,290	12.1
Wet alluvial land.....	2,700	1.2
Water.....	2,830	1.2
Total.....	226,560	100.0

<sup>1</sup> Less than 0.1 percent.

inches. The profile is neutral throughout.

Permeability in these soils is moderately rapid, and the available water capacity is low. Effective rooting depth is 60 inches or more. The soils normally do not have a water table, but during the irrigation season the water table is at a depth of 2 to 3 feet as a result of ditch losses and seepage.

Adilis soils are used for irrigated hay and pasture.

Representative profile of Adilis loam, 1 to 5 percent slopes, 150 feet west and 40 feet north of the southeast corner of sec. 36, T. 50 N., R. 8 E., Chaffee County:

O1—1 inch to 0, organic mat; slightly calcareous.

A1—0 to 4 inches, grayish-brown (10YR 5/2) loam; very dark grayish brown (10YR 3/2) moist; weak, fine, granular structure; slightly hard, friable, slightly sticky; slightly calcareous; neutral; clear, smooth boundary.

C1—4 to 17 inches, brown (10YR 5/3) coarse sandy loam; dark brown (10YR 4/3) moist; very weak, medium, subangular blocky structure; hard, friable, non-sticky; neutral; clear, smooth boundary.

C2—17 to 23 inches, brown (10YR 5/3) gravelly sandy loam; dark brown (10YR 3/3) moist; few, fine, distinct mottles of yellowish brown (10YR 5/6); massive; slightly hard, very friable, nonsticky; 30 percent gravel; neutral; clear, smooth boundary.

IIC3—23 to 60 inches, sand, gravel, and cobbles; strongly calcareous in spots.

The organic mat on the surface, where present, ranges from 1 to 3 inches in thickness. The A horizon ranges from very dark grayish brown to dark brown. It is loam or sandy loam. Depth to the IIC horizon ranges from 15 to 30 inches.

**Adilis loam, 1 to 5 percent slopes (AdC).**—This soil is on low terraces in the southwestern part of Chaffee County. Areas generally are long and narrow. Included with this soil in mapping are small areas of Gas Creek soils, Manhattan sandy loam, 1 to 3 percent slopes, and Chaffee soils.

Surface runoff is medium, and the hazard of erosion is slight. Most of the acreage is used for irrigated meadow that is harvested for hay and used for pasture. (Capability unit IVw-1, irrigated)

### Antero Series

The Antero series consists of deep, poorly drained soils on broad, low terraces. These soils formed in stratified, calcareous, moderately coarse textured alluvium. Slopes range from 1 to 3 percent. Elevation ranges from 7,000 to 8,000 feet. The plant cover is irrigated, water-tolerant grasses and sedges. The average annual precipitation is 11 to 15 inches. The average annual soil temperature is 45° F., and the average soil temperature in summer is 63°. The frost-free season is 75 to 100 days.

In a representative profile the surface layer is very dark brown and dark grayish-brown sandy loam about 7 inches thick. The subsoil is dark grayish-brown sandy loam that has yellowish-brown mottles and is about 7 inches thick. The substratum is dark grayish-brown, grayish-brown, and dark-brown, stratified loamy coarse sand and sandy loam. It overlies gravel and cobbles at a depth of 54 inches. The soil is mildly alkaline at the surface and moderately alkaline below a depth of about 2 inches. The profile is calcareous throughout.

Permeability in these soils is moderately rapid, and the available water capacity is moderate. Effective root-

ing depth is 60 inches or more. A seasonal high water table is at a depth of 0 to 1 foot.

Most of the acreage of these soils is irrigated and in meadow, which is cut for hay and also is grazed early and late in the growing season.

Representative profile of Antero sandy loam, 1 to 3 percent slopes, in a grass meadow 170 feet north of the SE corner sec 27, T. 15 S., R. 78 W., Chaffee County:

A11—0 to 2 inches, very dark grayish-brown (10YR 3/2) sandy loam; very dark brown (10YR 2/2) moist; weak, fine, granular structure; soft, friable, non-sticky; many fine roots; highly organic; slightly calcareous; mildly alkaline; abrupt, smooth boundary.

A12g—2 to 7 inches, grayish-brown (10YR 5/2) sandy loam; dark grayish brown (10YR 4/2) moist; many, medium, distinct, yellowish-brown (10YR 5/4) mottles; weak, fine, subangular blocky structure parting to weak, fine, granular; slightly hard, friable, non-sticky; strongly calcareous; moderately alkaline; clear, smooth boundary.

B2g—7 to 14 inches, grayish-brown (10YR 5/2) sandy loam; dark grayish brown (10YR 4/2) moist; many, medium, distinct, yellowish-brown (10YR 5/4) mottles; weak, medium, subangular blocky structure; slightly hard, very friable, nonsticky; strongly calcareous; moderately alkaline; gradual, smooth boundary.

C1g—14 to 20 inches, grayish-brown (10YR 5/2) loamy coarse sand; dark grayish brown (10YR 4/2) moist; few, fine, distinct, yellowish-brown (10YR 5/4) mottles; massive; slightly hard, very friable, nonsticky; calcareous; moderately alkaline; clear, wavy boundary.

C2cag—20 to 36 inches, dark grayish-brown (10YR 4/2) moist, mixed with grayish-brown (2.5YR 5/2) moist, sandy loam; many, medium and coarse, distinct, dark yellowish-brown (10YR 4/4) mottles; massive; slightly hard, very friable, nonsticky; very strongly calcareous with visible lime as streaks and spots; moderately alkaline; gradual, smooth boundary.

C3g—36 to 54 inches, brown (10YR 5/3) sandy loam; dark brown (10YR 4/3) moist; many, medium, distinct, yellowish-brown (10YR 5/6) mottles; massive; slightly hard, very friable, nonsticky; slightly calcareous; moderately alkaline; clear, smooth boundary.

IIC4—54 to 60 inches, gravel and cobbles.

A thin organic mat is at the surface in places. The A12 horizon is gray to dark grayish brown. Reaction ranges from 7.4 to 8.4. Depth from the surface to mottling ranges from 2 to 10 inches. The B2g horizon is dark grayish brown or light grayish brown. Reaction ranges from 7.9 to 8.4. Mottles range from few to many and from faint to distinct. Depth to the C horizon ranges from 12 to 20 inches. A contrasting IIC horizon does not occur above a depth of 40 inches.

**Antero sandy loam, 1 to 3 percent slopes (AnB).**—This soil is on terraces that generally have western exposures. It is in the central part of Chaffee County in the vicinity of Nathrop. The mapped areas are long and narrow. Included with this soil in mapping are small areas of Collegiate loam and Gas Creek gravelly sandy loam, 1 to 3 percent slopes.

Runoff is slow, and the hazard of erosion is slight. All of the acreage of this soil is used for irrigated meadow. (Capability unit IVw-1, irrigated)

## Badland

Badland (Bo) consists of severely eroded, stratified sediments of clay, silt, and fine sand. Dominant slopes range from 10 to more than 50 percent. Included in mapping are nearly vertical walls and gullied areas.

Badland is mainly in the northern part of Chaffee County and the southeastern part of Lake County. It is the result of geologic erosion of the Dry Union Formation. The plant cover is very sparse and is dominantly stunted pinyon pine and juniper trees. Indian ricegrass and blue grama make up a limited understory, but they are not of sufficient extent to stabilize the surface from washing or to provide grazing. (Capability unit VIIIe-1, nonirrigated)

## Blanyon Series

The Blanyon series consists of deep, well-drained soils on low terraces. These soils formed in calcareous, fine-textured alluvium. Slopes range from 1 to 3 percent. Elevation ranges from 7,000 to 7,800 feet. The plant cover is big sagebrush and wheatgrasses on the few small areas that are not irrigated. The average annual precipitation is 10 to 14 inches. The average annual soil temperature is 46° F., and the average soil temperature in summer is 64°. The frost-free season is 85 to 110 days.

In a representative profile the surface layer is dark grayish-brown clay loam about 8 inches thick. The subsoil is dark grayish-brown silty clay loam about 14 inches thick. The substratum is dark-brown and dark yellowish-brown silty clay that extends to a depth of 60 inches. The profile is moderately alkaline throughout and is strongly calcareous below a depth of about 22 inches.

Permeability in these soils is slow, and the available water capacity is high. Effective rooting depth is 60 inches or more.

Most areas of these soils are used for irrigated alfalfa. Such small grains as oats and barley are grown occasionally.

Representative profile of Blanyon clay loam, 1 to 3 percent slopes, 1,000 feet east and 50 feet south of the west quarter corner (south side of the road) sec. 26, T. 50 N., R. 8 E., Chaffee County:

Ap—0 to 8 inches, grayish-brown (10YR 5/2) clay loam; dark grayish brown (10YR 4/2) moist; moderate, coarse, prismatic structure parting to moderate, medium, subangular blocky; very hard, firm, sticky; many fine and coarse roots; few fine pores; slightly calcareous; moderately alkaline; clear, smooth boundary.

B21t—8 to 15 inches, light brownish-gray (10YR 6/2) silty clay loam; dark grayish brown (10YR 4/2) moist; moderate, coarse, prismatic structure parting to moderate, medium, subangular blocky; very hard, firm, sticky; thin clay films on vertical and horizontal faces of peds; slightly calcareous; moderately alkaline; clear, smooth boundary.

B22t—15 to 22 inches, light brownish-gray (10YR 6/2) silty clay loam; dark grayish brown (10YR 4/2) moist; moderate, coarse, prismatic structure parting to moderate, medium, subangular blocky; very hard, firm, sticky; thin clay films on vertical and horizontal faces of peds; slightly calcareous; moderately alkaline; clear, smooth boundary.

C1ca—22 to 48 inches, brown (10YR 5/3) silty clay; dark brown (10YR 4/3) moist; massive; very hard, firm, sticky; few coarse roots; strongly calcareous with lime mycelia in root channels; moderately alkaline; gradual, smooth boundary.

C2ca—48 to 60 inches, yellowish-brown (10YR 5/4) silty clay; dark yellowish brown (10YR 4/4) moist; mas-

sive; very hard, firm, sticky; very strongly calcareous; moderately alkaline.

The A horizon ranges from dark grayish brown to brown. Reaction ranges from 7.9 to 8.4. The B horizon ranges from pale brown to dark grayish brown. It is silty clay loam, light clay, or silty clay.

**Blanyon clay loam, 1 to 3 percent slopes (B/B).**—This soil is on low terraces in the southern part of Chaffee County, generally on the south side of the South Arkansas River. Included with this soil in mapping are small areas of Dominson gravelly sandy loam and Hawksell sandy loam.

Surface runoff is slow, and the hazard of erosion is moderate. Most of the acreage of this soil is used for irrigated alfalfa. Such small grains as oats and barley are grown in some fields. (Capability unit IVE-2, irrigated, VIe-2, nonirrigated)

### Bross Series

The Bross series consists of deep, well-drained soils on mountains near or above timberline. These soils formed in mixed cobbly and gravelly, moderately coarse textured outwash materials. Slopes range from 9 to 45 percent. Elevation ranges from 10,000 to 14,000 feet. The plant cover is alpine grasses, sedges, forbs, and clovers. The average annual precipitation is 20 to 30 inches. The average annual soil temperature is 30° F., and the average soil temperature in summer is 42°. The frost-free season is less than 10 days.

In a representative profile the surface layer is very dark grayish-brown gravelly sandy loam about 8 inches thick. The subsurface layer is brown very cobbly sandy loam about 4 inches thick. The subsoil is yellowish-brown very cobbly fine sandy loam about 7 inches thick. The substratum is brown very cobbly sandy loam that is several feet thick. The profile is strongly acid throughout.

Permeability in these soils is moderately rapid, and the available water capacity is moderate. Effective rooting depth is 60 inches or more.

These soils are in native range that is grazed in summer by sheep, cattle, deer, and elk.

Representative profile of Bross gravelly sandy loam, 9 to 45 percent slopes, 6 miles east of Leadville, along the Mosquito Pass road in the mining district, T. 9 S., R. 79 W., Lake County:

O2—2 inches to 0, partly decomposed organic mat.

A1—0 to 8 inches, grayish-brown (10YR 5/2) gravelly sandy loam; very dark grayish brown (10YR 3/2) moist; weak, fine, granular structure; slightly hard, very friable, nonsticky; many fine roots; 45 percent gravel and cobbles; strongly acid; clear, smooth boundary.

A2—8 to 17 inches, pale-brown (10YR 6/3) very cobbly sandy loam; brown (10YR 5/3) moist; weak, thin, platy structure; slightly hard, very friable, nonsticky; common fine roots; 55 percent cobbles and gravel; strongly acid; clear, wavy boundary.

B2—17 to 24 inches, light yellowish-brown (10YR 6/4) very cobbly fine sandy loam; yellowish-brown (10YR 6/4) very cobbly fine sandy loam; yellowish brown (10YR 5/4) moist; weak, medium, subangular blocky structure; slightly hard, friable, nonsticky; few fine roots; 50 percent cobbles and gravel; strongly acid; clear, smooth boundary.

C—24 to 60 inches, pale-brown (10YR 6/3) very cobbly sandy loam; brown (10YR 5/3) moist; massive;

slightly hard, friable, nonsticky; 70 percent cobbles and gravel; strongly acid.

The A horizon ranges from very dark brown to brown. Reaction is 5.1 to 5.5. The B horizon is yellowish brown to dark yellowish brown. Reaction is 4.5 to 5.5. Depth to parent material is 20 to 30 inches. The average content of gravel and cobbles in the soil profile ranges from 50 to 70 percent.

**Bross gravelly sandy loam, 9 to 45 percent slopes (B/F).**—This soil is on mountains at or above timberline in the northeastern part of Lake County on the west flank of the Mosquito Range. Soil areas are irregularly shaped and generally are larger than 40 acres in size. Included with this soil in mapping are small areas of Troutville gravelly sandy loam, Rock outcrop, and Rock slides.

Surface runoff is rapid, and the hazard of erosion is moderate. All the acreage of this soil is in native range that is used for summer grazing by sheep, cattle, deer, and elk. (Capability unit VIIe-2, nonirrigated; Alpine Slopes range site)

### Cabin Series

The Cabin series consists of deep, well-drained soils on mountains and terrace edges. The soils formed in loamy alluvium superimposed over very cobbly, coarse-textured outwash materials. Slopes range from 9 to 25 percent. Elevation ranges from 8,000 to 9,000 feet. The plant cover is big sagebrush and mid grasses. The average annual precipitation is 11 to 15 inches. The average annual soil temperature is 42° F., and the average soil temperature in summer is 56°. The frost-free season is 55 to 75 days.

In a representative profile the surface layer is dark-brown gravelly sandy loam about 6 inches thick. The subsoil is dark yellowish-brown sandy clay loam about 16 inches thick. The lower part of the subsoil is cobbly. The substratum is brown very cobbly loamy fine sand that extends to a depth of 60 inches or more. The profile is neutral throughout.

Permeability in these soils is moderate, and the available water capacity is low. Effective rooting depth is 60 inches or more.

Representative profile of Cabin gravelly sandy loam, 9 to 25 percent slopes, in native range at the west quarter corner of sec. 14, T. 49 N., R. 7 E., Chaffee County:

A1—0 to 6 inches, dark-brown (10YR 4/3) gravelly sandy loam; dark brown (10YR 3/3) moist; weak, fine, granular structure; slightly hard, very friable, nonsticky; many fine and coarse roots; neutral; clear, smooth boundary.

B21t—6 to 16 inches, yellowish-brown (10YR 5/4) fine sandy clay loam; dark yellowish brown (10YR 4/4) moist; weak, medium, subangular blocky structure; hard, friable, slightly sticky; many fine and coarse roots; thin patchy clay films on faces of peds; 10 percent gravel; neutral; gradual, smooth boundary.

B22t—16 to 22 inches, light yellowish-brown (10YR 6/4) cobbly fine sandy clay loam; dark yellowish brown (10YR 4/4) moist; very weak, medium, subangular blocky structure; hard, friable, slightly sticky; few coarse roots; very thin patchy clay films on faces of peds; 30 percent gravel and cobbles; neutral; gradual, wavy boundary.

IIC—22 to 60 inches, very pale brown (10YR 7/4) very cobbly loamy fine sand; brown (10YR 5/3) moist;

single grained; loose when dry or moist; 60 percent cobbles and gravel; neutral.

The A horizon is very dark grayish brown or dark brown. Content of cobbles and gravel ranges from 5 to 30 percent. Reaction is 6.1 to 7.3. The B horizon ranges from dark brown to yellowish brown. It is fine sandy clay loam, cobbly fine sandy clay loam, or gravelly sandy clay loam. Content of gravel and cobbles ranges from 10 to 30 percent. Reaction is 6.6 to 7.3.

**Cabin gravelly sandy loam, 9 to 25 percent slopes (CoE).**—This soil is on mountains and terrace edges in the southern part of Chaffee County. Included with it in mapping are small areas of Pierian gravelly sandy loam and other Pierian soils.

Surface runoff is medium, and the hazard of erosion is moderate. Most of the acreage of this soil is in native range and is used for grazing and recreation. (Capability unit VIe-3, nonirrigated; Mountain Outwash range site)

### Chaffee Series

The Chaffee series consists of deep, poorly drained soils on stream bottoms. These soils formed in moderately coarse textured alluvium. Slopes range from 1 to 3 percent. Elevation ranges from 7,000 to 8,500 feet. The plant cover is grasses, sedges, and rushes. The average annual precipitation is 11 to 15 inches. The average annual soil temperature is 46° F., and the average soil temperature in summer is 64°. The frost-free season is 75 to 110 days.

In a representative profile the surface layer is very dark brown loam and very dark grayish-brown fine sandy loam, about 16 inches thick, that is mottled in the lower part. The subsoil is mottled, very dark gray fine sandy loam that is stratified with sandy loam and loamy sand and is about 24 inches thick. The substratum is sand, gravel, and cobbles. The soil is neutral in the surface layer and mildly alkaline below that depth.

Permeability in these soils is moderate, and the available water capacity is moderate. Effective rooting depth is 60 inches or more. Seasonal high water table rises to within a depth of 1 foot.

Most of the acreage of these soils is used for grass meadows. A few fields are in alfalfa.

Representative profile of Chaffee loam, 1 to 3 percent slopes, 600 feet south and 200 feet east of the northwest corner of sec. 12, T. 49 N., R. 8 E., Chaffee County:

A11—0 to 4 inches, dark grayish-brown (10YR 4/2) loam; very dark brown (10YR 2/2) moist; weak, fine, granular structure; slightly hard, friable, non-sticky; many fine roots; highly organic; large percentage of mica flakes; slightly calcareous; neutral; clear, smooth boundary.

A12g—4 to 11 inches, dark grayish-brown (10YR 4/2) loam; very dark brown (10YR 2/2) moist; common, fine, distinct, dark-brown (7.5YR 4/4) mottles; weak, very fine, subangular blocky structure; slightly hard, friable, slightly sticky; many fine roots; many mica flakes; slightly calcareous in spots; neutral; gradual, smooth boundary.

A13g—11 to 16 inches, grayish-brown (2.5Y 5/2) fine sandy loam; very dark grayish brown (2.5YR 3/2) moist; many, medium, distinct, dark-brown (7.5YR 4/4) mottles; weak, medium and fine, subangular blocky structure; hard, friable, nonsticky; many fine and medium roots; many mica flakes; neutral; gradual, wavy boundary.

B2g—16 to 40 inches, gray (5Y 5/1) fine sandy loam stratified with sandy loam and loamy sand; very dark gray (5Y 3/1) moist; common, large, distinct, very dark grayish-brown (2.5Y 3/2) and dark-brown (7.5YR 4/4) mottles; massive; hard, friable, non-sticky; common medium and fine roots; mildly alkaline; clear, wavy boundary.

IICg—40 to 60 inches, sand, gravel, and cobbles.

The A horizon ranges from black to very dark grayish brown. An organic mat, 1 to 3 inches thick, is on the surface in places. The B horizon is very dark gray or dark gray. A IIC horizon of sand, gravel, and cobbles is between depths of 40 and 60 inches in most places.

**Chaffee loam, 1 to 3 percent slopes (ChB).**—This soil is on long narrow bottoms along the main rivers and streams in Chaffee County. Included with it in mapping are small areas of Sawatch sandy loam and Wet alluvial land.

Surface runoff is slow, and the hazard of erosion is slight. Most of the acreage of this soil is in irrigated meadow. A few fields are in alfalfa. (Capability unit IVw-1, irrigated)

### Collegiate Series

The Collegiate series consists of somewhat poorly drained soils on broad low terraces. These soils are moderately deep over gravel and cobbles. They formed in moderately coarse textured alluvium. Slopes range from 1 to 3 percent. Elevation ranges from 7,000 to 8,500 feet. The plant cover is water-tolerant grasses and sedges. The average annual precipitation is 11 to 15 inches. The average annual soil temperature is 46° F., and the average soil temperature in summer is 64°. The frost-free season is 75 to 110 days.

In a representative profile the surface layer is covered by a 2-inch mat of organic material. The surface layer, about 36 inches thick, is very dark grayish brown. The upper 4 inches is loam, and the lower 32 inches is sandy clay loam and sandy loam that is mottled in the lower part. The substratum is gravel and cobbles; it extends to a depth of 60 inches or more. The soil is neutral to a depth of about 9 inches and is mildly alkaline below that depth.

Permeability in these soils is moderate, and the available water capacity is moderate. Effective rooting depth is 60 inches or more. A seasonal high water table is at a depth of 2 to 3 feet.

All the acreage of these soils is irrigated. Most of the acreage is in plants that are cut for hay but are also grazed early and late in the growing season. A few small fields are planted to oats and barley.

Representative profile of Collegiate loam, 1 to 3 percent slopes, in a grass meadow 360 feet east of steel gate then 220 feet north in the SW $\frac{1}{4}$  sec. 26, T. 15 S., R. 78 W., Chaffee County:

O1—2 inches to 0, fibrous organic mat containing more than 30 percent organic matter.

A11—0 to 4 inches, dark grayish-brown (10YR 4/2) loam; very dark grayish brown (10YR 3/2) moist; moderate, fine, granular structure; soft, friable, slightly sticky; many fine roots; neutral; clear, smooth boundary.

A12—4 to 9 inches, dark grayish-brown (10YR 4/2) light sandy clay loam; very dark grayish brown (10YR 3/2) moist; moderate, fine and very fine, subangular blocky structure; hard, friable, slightly sticky; neutral; clear, smooth boundary.

A13g—9 to 26 inches, grayish-brown (10YR 5/2) sandy loam; very dark grayish brown (10YR 3/2) moist; common, medium, distinct, light olive-brown (2.5YR 5/6) mottles; moderate, medium, subangular blocky structure; hard, friable, nonsticky; mildly alkaline; gradual, wavy boundary.

A14g—26 to 36 inches, grayish-brown (10YR 5/2) sandy loam; very dark grayish brown (10YR 3/2) moist; many light olive-brown (2.5YR 5/6) mottles; structureless; slightly hard, very friable, nonsticky; mildly alkaline; gradual, wavy boundary.

IIC—36 to 60 inches, gravel and cobbles.

The A horizon ranges from dark brown to very dark grayish brown. It ranges from loam or sandy loam to light sandy clay loam. Reaction is 6.6 to 7.8. Mottles are at or near the surface. Depth to cobbles and gravel ranges from 20 to 40 inches.

**Collegiate loam, 1 to 3 percent slopes (CIB).**—This soil is on broad low terraces that have a western exposure. It is in the central part of Chaffee County. Areas generally are long and narrow. The depth to the water table fluctuates and depends on the amount of irrigation. Included with this soil in mapping are small areas of Antero sandy loam and Gas Creek gravelly sandy loam.

Surface runoff is slow, and the hazard of erosion is slight. Most areas of this soil are used as irrigated meadow. (Capability unit IVw-1, irrigated)

### Costilla Series

The Costilla series consists of well-drained soils on colluvial-alluvial fans. These soils are moderately deep over very gravelly material. They formed in gravelly, moderately coarse textured alluvium. Slopes range from 3 to 9 percent. Elevation ranges from 7,000 to 8,000 feet. The plant cover is big sagebrush and short grasses. The average annual precipitation is 10 to 14 inches. The average annual soil temperature is 46° F., and the average soil temperature in summer is 63°. The frost-free season is 80 to 100 days.

In a representative profile the surface layer is very dark grayish-brown and dark grayish-brown gravelly coarse sandy loam about 8 inches thick. Next is a layer of brown gravelly sandy loam about 13 inches thick. Below this, to a depth of 35 inches, is brown gravelly coarse sand and stratified gravelly loamy coarse sand and sandy loam. Below this and extending to a depth of 60 inches, is dark grayish-brown and dark-brown very gravelly coarse sand. Lime content increases with increasing depth. The reaction ranges from neutral at the surface to strongly alkaline in the lower part of the underlying material.

Permeability in these soils is moderately rapid, and the available water capacity is low. Effective rooting depth is 60 inches or more.

Most of the acreage of these soils is in range that is grazed by cattle and sheep.

Representative profile of Costilla gravelly coarse sandy loam, 3 to 9 percent slopes, in native range 130 feet west of fence bordering the highway in NE $\frac{1}{4}$  sec. 9, T. 50 N., R. 8 E., Chaffee County:

A11—0 to 3 inches, grayish-brown (10YR 5/2) gravelly coarse sandy loam; very dark grayish brown (10YR 3/2) moist; moderate, fine, granular structure; soft, very friable, nonsticky; many fine and medium

roots; 15 percent fine gravel; neutral; clear, smooth boundary.

A12—3 to 8 inches, grayish-brown (10YR 5/2) gravelly coarse sandy loam; dark grayish brown (10YR 4/2) moist; weak, medium, prismatic structure; very hard, very friable, nonsticky; common medium roots; 20 percent gravel; mildly alkaline; clear, smooth boundary.

C1ca—8 to 21 inches, pale-brown (10YR 6/3) gravelly sandy loam; brown (10YR 5/3) moist; weak, medium, prismatic structure parting to weak, coarse, subangular blocky; very hard, very friable, nonsticky; common medium roots; 20 percent gravel; strongly calcareous with many fine segregations of white lime; moderately alkaline; clear, wavy boundary.

C2ca—21 to 25 inches, pale-brown (10YR 6/3) gravelly coarse sand; brown (10YR 5/3) moist; single grained; loose when dry and moist; few fine roots; 30 percent gravel; strongly calcareous with common fine segregations of white lime; moderately alkaline; clear, wavy boundary.

C3ca—25 to 35 inches, pale-brown (10YR 6/3) stratified gravelly loamy coarse sand and sandy loam; brown (10YR 4/3) moist; moderate, fine, subangular blocky structure; soft, very friable, nonsticky; 30 percent gravel and cobbles; strongly calcareous with common fine segregations of white lime; strongly alkaline; clear, wavy boundary.

C4—35 to 60 inches, light brownish-gray and pale-brown (10YR 6/2) (10YR 6/3) very gravelly coarse sand; dark grayish brown and dark brown (10YR 4/2) (10YR 4/3) moist; single grained; loose when dry and moist; 60 percent gravel and cobbles; strongly calcareous; strongly alkaline.

The A horizon ranges from grayish brown to very dark grayish brown. It generally is noncalcareous, but in some places, it is weakly calcareous. Reaction is 6.6 to 8.4. The C horizon, to a depth of 40 inches, typically averages gravelly sand or gravelly loamy sand. Stratification between depths of 10 and 40 inches is common. The content of gravel and cobbles ranges from 15 to 35 percent.

Costilla soils, as mapped in this area, are outside the defined range for the series because they have stratification of sandy loam within the 10- to 40-inch control section.

**Costilla gravelly sandy loam, 3 to 9 percent slopes (CoD).**—This soil is on farms in the southern part of Chaffee County, west of the Arkansas River. Areas generally are more than 40 acres in size and are long and moderately wide. Included with this soil in mapping are small areas of Hawksell sandy loam and a few isolated areas of Rough broken land.

Surface runoff is slow, and the hazard of erosion is moderate. Most of the acreage of this soil is in native range and is used for grazing. (Capability unit VIe-1, irrigated, VIe-3, nonirrigated; Sandy Bench range site)

### Cotopaxi Series

The Cotopaxi series consists of deep, well-drained soils on valley slopes and low terraces. These soils formed in reworked eolian sands. Slopes range from 3 to 9 percent. Elevation ranges from 7,000 to 7,700 feet. The plant cover is grass and a small amount of woody plants. The average annual precipitation is 10 to 14 inches. The average annual soil temperature is 46° F., and the average soil temperature in summer is 64°. The frost-free season is 85 to 110 days.

In a representative profile the surface layer is dark grayish-brown loamy fine sand about 3 inches thick. The underlying material is brown, dark-brown, dark



grayish-brown, and yellowish-brown fine sand that extends to a depth of 60 inches or more. The soil is neutral in the surface layer and mildly alkaline below that depth.

Permeability in these soils is rapid, and the available water capacity is low. Effective rooting depth is 60 inches or more.

Most of the acreage of these soils is in native range. A small acreage is used for irrigated crops.

Representative profile of Cotopaxi loamy fine sand, 3 to 9 percent slopes, under native grass, 1,560 feet west and 800 feet south of the northeast corner of sec. 24, T. 50 N., R. 9 E., Chaffee County:

- A1—0 to 3 inches, brown (10YR 5/3) loamy fine sand; dark grayish brown (10YR 4/2) moist; single grained; loose when dry and moist; many fine and medium roots; few, scattered, small pebbles; neutral; clear, smooth boundary.
- C1—3 to 24 inches, brown (10YR 5/3) fine sand; dark brown (10YR 4/3) moist; single grained; loose when dry and moist; common fine and medium roots; mildly alkaline; clear, smooth boundary.
- C2—24 to 36 inches, grayish-brown (10YR 5/2) fine sand; dark grayish brown (10YR 4/2) moist; single grained; loose when dry and moist; few fine roots; mildly alkaline; clear, smooth boundary.
- C3—36 to 48 inches, pale-brown (10YR 6/3) fine sand; brown (10YR 5/3) moist; single grained; loose when dry and moist; few cobbles and pebbles; mildly alkaline; clear, smooth boundary.
- C4—48 to 60 inches, light yellowish-brown (10YR 6/4) fine sand; yellowish brown (10YR 5/4) moist; single grained; loose when dry and moist; mildly alkaline.

The A horizon is dark grayish brown or grayish brown. Reaction is 6.6 to 7.8. The C horizon ranges from yellowish brown to dark brown or dark grayish brown. It ranges from fine sand to coarse sand. Reaction is 7.4 to 7.8. The soil is less than 15 percent gravel and cobbles.

**Cotopaxi loamy sand, 3 to 9 percent slopes (CtD).**—This soil is on valley slopes and low terraces in the southeastern part of Chaffee County, east of the Arkansas River. Included with it in mapping are small areas of Ouray sandy loam.

Surface runoff is slow. The hazard of soil blowing is high, and that of water erosion is moderate. Most areas of this soil are in native range that is used for grazing. A small acreage is irrigated and is used for growing alfalfa. (Capability unit VIe-1, irrigated, VIe-3, nonirrigated; Sandy Bench range site)

## Dominson Series

The Dominson series consists of somewhat excessively drained soils on terraces and terrace edges. These soils are very shallow over cobbles, gravel, and sand. They formed in gravelly, moderately coarse textured outwash. Slopes range from 1 to 45 percent. Elevation ranges from 7,200 to 8,800 feet. The plant cover is mainly short and mid grasses, but there is an overstory of pinyon pine and juniper on some of the steeper slopes. The average annual precipitation is 11 to 16 inches. The average annual soil temperature is 46° F., and the average soil temperature in summer is 64°. The frost-free season is 75 to 100 days.

In a representative profile the surface layer is dark-brown gravelly sandy loam about 6 inches thick. The next layer is dark-brown very gravelly sandy loam about 5 inches thick. Below this is mixed gravel and cobbles that extend to a depth of 60 inches or more.

The soil is neutral in the uppermost 3 inches and mildly alkaline below that depth.

Permeability in these soils is very rapid, and the available water capacity is low. Effective rooting depth is 60 inches or more.

Most areas of the Dominson soils are in range and are used for grazing (fig. 7). A small acreage is used for irrigated hay.

Representative profile of Dominson gravelly sandy loam, 1 to 9 percent slopes, in native range near the center of SW $\frac{1}{4}$  sec. 15, T. 15 S., R. 78 W., Chaffee County:

- A11—0 to 3 inches, brown (10YR 5/3) gravelly sandy loam; dark brown (10YR 3/3) moist; weak, thin, platy structure parting to weak, fine, granular; slightly hard, very friable, nonsticky; many fine and medium roots; 15 percent gravel and cobbles; neutral; clear, smooth boundary.
- A12—3 to 6 inches, brown (10YR 5/3) gravelly sandy loam; dark brown (10YR 3/3) moist; weak, medium, subangular blocky structure; slightly hard, friable, nonsticky; many fine and medium roots; 15 percent gravel and cobbles; mildly alkaline; clear, wavy boundary.
- AC—6 to 11 inches, dark-brown (10YR 4/3) very gravelly sandy loam; dark brown (10YR 3/3) moist; weak, medium, subangular blocky structure; slightly hard, friable, nonsticky; common fine and medium roots; 50 percent gravel and cobbles; mildly alkaline; gradual, wavy boundary.
- IIC—11 to 60 inches, mixed igneous cobbles, gravel, and sand; lime coatings in places on underside of large gravel.

The A horizon generally ranges from 5 to 8 inches in thickness, but where there is no AC horizon, the A horizon is 7 to 15 inches thick. This horizon is very dark brown or dark brown. Gravel and cobbles cover 5 to 25 percent of the soil surface. Reaction ranges from 6.6 to 7.8. Depth to the IIC horizon ranges from 8 to 16 inches.

**Dominson gravelly sandy loam, 1 to 9 percent slopes (DoD).**—This soil is on alluvial fans and high terraces in nearly all parts of Chaffee County. It has the profile described as representative of the series. Included with this soil in mapping are small areas of St. Elmo gravelly sandy loam, 1 to 3 percent slopes.

Surface runoff is medium, and the hazard of erosion is moderate. About 80 percent of the acreage is in range that is used for grazing. The remaining 20 percent is in irrigated hay, mainly alfalfa. Most of the irrigation is in areas where slopes are 3 to 5 percent. (Capability unit VIe-1, irrigated, VIe-3, nonirrigated; Dry Mountain Outwash range site)

**Dominson gravelly sandy loam, 9 to 45 percent slopes (DoF).**—This soil is in long, narrow areas along terrace edges in nearly all parts of Chaffee County. It has a profile similar to that described as representative of the series, but the depth to the underlying material is less than 11 inches, and in most places there is a larger amount of gravel and cobbles on the surface. Included with this soil in mapping are small areas of Rough broken land and St. Elmo gravelly sandy loam, 9 to 45 percent slopes.

Surface runoff is rapid, and the hazard of erosion is severe. All of this soil is in grass and is used for grazing. Some areas have an overstory of pinyon pine and juniper. (Capability unit VIIe-1, nonirrigated; woodland suitability group 3; Dry Mountain Outwash range site)

### Gas Creek Series

The Gas Creek series consists of poorly drained soils on low terraces. These soils are shallow to very shallow over gravel, cobbles, and sand. They formed in gravelly, moderately coarse textured materials. Slopes range from 1 to 3 percent. Elevation ranges from 7,000 to 8,500 feet. The plant cover is grasses, sedges, and rushes. The average annual precipitation is 11 to 15 inches. The average annual soil temperature is 46° F., and the average soil temperature in summer is 64°. The frost-free season is 75 to 110 days.

In a representative profile a thin mat of organic material is on the surface. The surface layer is mottled, dark-brown gravelly sandy loam about 13 inches thick. The underlying material is mixed gravel, cobbles, and sand. The profile is neutral throughout.

Permeability in these soils is very rapid, and the available water capacity is low. Effective rooting depth is 60 inches or more. A seasonal high water table is at a depth of 0 to 1 foot.

Most of the acreage of these soils is irrigated and is used for producing grass hay.

Representative profile of Gas Creek gravelly sandy

loam, 1 to 3 percent slopes, in a meadow 90 feet north of the southwest corner of sec. 22, T. 15 S., R. 78 W., Chaffee County:

O1—3 inches to 0, undecomposed and partly decomposed organic material.

A1g—0 to 13 inches, brown (7.5YR 5/2) gravelly sandy loam; dark brown (7.5YR 3/2) moist; common, medium, distinct, reddish-yellow and dark-gray (7.5YR 6/8) (5Y 4/1) mottles; moderate, fine, granular structure; slightly hard, friable, slightly sticky; many fine and medium roots; 45 percent fine gravel; neutral; clear, smooth boundary.

IICg—13 to 60 inches, igneous gravel, cobbles, and sand.

The A horizon is dark brown or very dark brown. Content of gravel and cobbles ranges from 15 to 50 percent. Mottling is within 6 inches of the surface. Reaction is 6.6 to 7.3. Depth to the IIC horizon ranges from 10 to 18 inches. This horizon is mixed cobbles, gravel, and sand. It consists of 60 to 90 percent cobbles and gravel mixed with sand.

**Gas Creek gravelly sandy loam, 1 to 3 percent slopes (GcB).**—This soil is on low terraces in the vicinity of Nathrop and Buena Vista. Included with it in mapping are small areas of Antero sandy loam and Collegiate loam.

Surface runoff is slow, and the hazard of erosion is slight. Most of the acreage is irrigated and is used



Figure 7.—Dominion gravelly sandy loam in native range.

for growing grass hay. The hay meadows generally are grazed early in spring and late in fall. (Capability unit IVw-1, irrigated)

### Granile Series

The Granile series consists of deep, well-drained soils on mountains and high uplands. These soils formed in material weathered from gneiss, schist, and granite. Slopes range from 3 to 35 percent. Elevation ranges from 8,200 to 9,500 feet. The plant cover is Douglas-fir and lodgepole pine and a moderate understory of grasses and shrubs. The average annual precipitation is 12 to 18 inches. The average annual soil temperature is 38° F., and the average soil temperature in summer is 45°. The frost-free season is 20 to 60 days.

In a representative profile the surface layer is dark-brown gravelly sandy loam about 9 inches thick. It is underlain by about 9 inches of dark-brown gravelly sandy loam and reddish-brown gravelly clay loam. The subsoil is reddish-brown very gravelly clay loam and brown very gravelly loam about 23 inches thick. The substratum is weathered granite. The soil is medium acid in the surface layer and grades to neutral at a depth of 27 inches.

Permeability in these soils is moderate, and the available water capacity is low. Effective rooting depth is 40 inches or more.

The Granile soils are forested with Douglas-fir and lodgepole pine, but these trees are of little commercial value. The soils also are used for recreation.

Representative profile of Granile gravelly sandy loam, 3 to 35 percent slopes, in forest cover 0.7 mile east of the west edge of the bridge over the Arkansas River in the first drainage, NW $\frac{1}{4}$  sec. 32, T. 11 S., R. 79 W., Chaffee County:

- O2—2 inches to 0, few scattered pine needles over partly decomposed organic material.
- A2—0 to 9 inches, pinkish-gray (7.5YR 6/2) gravelly sandy loam; dark brown (7.5YR 4/2) moist; weak, fine, granular structure; slightly hard, very friable, nonsticky; common fine to coarse roots; 30 percent gravel; medium acid; clear, smooth boundary.
- A&B—9 to 18 inches, pinkish-gray (7.5YR 6/2) gravelly sandy loam, dark brown (7.5YR 4/2) moist, and lamellae of reddish-brown (5YR 5/4) gravelly clay loam, reddish brown (5YR 4/4) moist; weak, fine, granular structure; slightly hard, very friable, slightly sticky; common medium and coarse roots; 30 percent gravel; slightly acid; clear, wavy boundary.
- B2t—18 to 27 inches, reddish-brown (7.5YR 5/4) very gravelly clay loam; reddish brown (5YR 4/4) moist; weak, coarse, subangular blocky structure parting to moderate, medium, subangular blocky; hard, friable, sticky; common medium and coarse roots; thin nearly continuous clay films on vertical and horizontal faces of soil aggregates; 65 percent gravel; slightly acid; clear, wavy boundary.
- B3—27 to 41 inches, brown (7.5YR 5/4) very gravelly loam; dark brown (7.5YR 4/4) moist; weak, coarse, subangular blocky structure; slightly hard, very friable, slightly sticky; common coarse roots; 70 percent gravel; neutral; clear, wavy boundary.
- C—41 to 60 inches, brown (7.5YR 5/4) highly weathered granite.

The A2 horizon ranges from dark reddish gray to dark brown. Reaction is 5.6 to 6.5. The B horizon ranges from reddish brown to yellowish brown. It is very gravelly heavy

sandy clay loam to very gravelly clay loam. Content of gravel ranges from 50 to 70 percent. Reaction is 6.1 to 7.3.

**Granile gravelly sandy loam, 3 to 35 percent slopes (GrE).**—This soil is on mountain slopes and high, rolling uplands in the southern and western parts of Lake County and in northeastern Chaffee County. Included with this soil in mapping are small areas of Leadville sandy loam and a few small areas where depth to bed-rock is less than 40 inches. Also included are a few areas that have a surface layer of gravelly loamy sand.

Surface runoff is medium to rapid, and the hazard of erosion is moderate. All areas of this soil are forested with lodgepole pine and Douglas-fir that are of little commercial value. Grazing is very limited. This soil is used for wildlife habitat and for recreation. (Capability unit VIe-4, nonirrigated; woodland suitability group 2)

### Grantsdale Series

The Grantsdale series consists of well-drained soils on uplands. These soils are moderately deep over gravelly fine sand. They formed in medium-textured colluvial-alluvial sediments. Slopes range from 3 to 9 percent. Elevation ranges from 7,000 to 8,000 feet. The plant cover is grass and a small amount of woody plants. The average annual precipitation is 11 to 15 inches. The average annual soil temperature is 46° F., and the average soil temperature in summer is 64° F. The frost-free season is 75 to 100 days.

In a representative profile the surface layer is very dark grayish-brown fine sandy loam and dark-brown sandy clay loam about 9 inches thick. The subsoil, reaching to a depth of 27 inches, is brown fine sandy clay loam in the upper part and yellowish-brown loam in the lower part. The substratum is yellowish-brown gravelly fine sand. The soil is mildly alkaline to a depth of about 9 inches and moderately alkaline below that depth. It is calcareous below a depth of 18 inches.

Permeability in these soils is moderate, and the available water capacity is moderate. Effective rooting depth is 60 inches or more.

Most of the acreage of these soils is irrigated and is used to grow alfalfa. A few fields are in small grains.

Representative profile of Grantsdale fine sandy loam, 3 to 9 percent slopes, in an alfalfa field 150 feet south of the fence corner of intersection of the old and new U.S. Highway 285, in SW $\frac{1}{4}$  sec. 16, T. 51 N., R. 8 E., Chaffee County:

- Ap1—0 to 4 inches, grayish-brown (10YR 5/2) fine sandy loam; very dark grayish brown (10YR 3/2) moist; weak, very fine, granular structure; loose, very friable, slightly sticky; many fine and medium roots; mildly alkaline; clear, smooth boundary.
- Ap2—4 to 9 inches, grayish-brown (10YR 5/2) sandy clay loam; dark-brown (10YR 3/3) moist; weak, medium and coarse, subangular blocky structure; very hard, friable, sticky; common fine and medium roots; mildly alkaline; clear, smooth boundary.
- B2—9 to 18 inches, pale-brown (10YR 6/3) fine sandy clay loam; brown (10YR 5/3) moist; weak, medium and coarse, prismatic structure parting to weak, medium, subangular blocky; very hard, friable, sticky; common medium roots; moderately alkaline; clear, smooth boundary.
- B3ca—18 to 27 inches, pale-brown (10YR 6/3) loam; yellowish brown (10YR 5/4) moist; weak, medium,



subangular blocky structure; hard, friable, slightly sticky; few medium roots; strongly calcareous; few, fine, segregations of soft lime and coatings on small pebbles; moderately alkaline; clear, smooth boundary.

IIC—27 to 60 inches, light yellowish-brown (10YR 6/4) gravelly fine sand; yellowish brown (10YR 5/4) moist; single grained; noncalcareous; loose when dry and moist; grades into partly weathered Dry Union Formation at a depth of about 60 inches.

The A horizon is very dark grayish brown or dark brown. It is fine sandy loam or sandy clay loam. The B horizon ranges from dark brown to yellowish brown. Depth to the IIC horizon ranges from 20 to 40 inches. This horizon contains more than 35 percent coarse fragments.

The average annual precipitation on these soils is slightly less than the defined range for the series, but this difference does not alter their usefulness and behavior.

#### **Grantsdale fine sandy loam, 3 to 9 percent slopes (GsD).**

—This soil is on uplands in the southern part of Chaffee County. Included with it in mapping are small areas of Rough broken land and Manhattan sandy loam, 3 to 9 percent slopes.

Surface runoff is medium, and the hazard of erosion is moderate. Most of the acreage of this soil is irrigated and is used for growing hay. Alfalfa is the main crop. (Capability unit IVe-3, irrigated, VIe-3, nonirrigated; Sandy Bench range site)

#### **Gravelly Alluvial Land**

Gravelly alluvial land (Gv) is a gently sloping to sloping mapping unit that consists of highly stratified deposits of granitic gravel and sand. It is on fans and toe slopes along the Arkansas River. The fans and slopes are associated mainly with the granitic rock outcrops. There is little fine soil material. The surface is covered with cobbles and gravel in places, and in some areas there are scattered stones. The fans and toe slopes are subject to periodic deposition. There is little or no plant cover. Where plants are present, they are mostly weeds, rabbitbrush, and traces of grass.

This land is not suitable for range, because of the sparse, variable plant cover. (Capability unit VIIIs-1, nonirrigated)

#### **Hawksell Series**

The Hawksell series consists of deep, well-drained soils on colluvial-alluvial slopes and fans. These soils formed in calcareous, moderately coarse textured alluvium. Slopes range from 5 to 9 percent. Elevation ranges from 7,000 to 8,500 feet. The plant cover is grass and a small amount of woody plants. The average annual precipitation is 11 to 15 inches. The average annual soil temperature is 46° F., and the average soil temperature in summer is 64°. The frost-free season is 60 to 100 days.

In a representative profile the surface layer is dark grayish-brown sandy loam about 7 inches thick. The upper part of the underlying layer is dark-brown sandy loam about 13 inches thick. The lower part of the underlying layer, which extends to a depth of 60 inches, is dark grayish-brown sandy loam in the upper part and dark-brown heavy loamy sand in the lower part. The profile is moderately alkaline throughout and is calcareous below a depth of 7 inches.

Permeability in these soils is moderate, and the available water capacity is moderate. Effective rooting depth is 60 inches or more.

Most areas of these soils are irrigated and are used to grow alfalfa and small grains.

Representative profile of Hawksell sandy loam, 5 to 9 percent slopes, in a grain field one-fourth mile east of the southwest corner of sec. 36, T. 50 N., R. 8 E., Chaffee County:

Ap—0 to 7 inches, grayish-brown (10YR 5/2) sandy loam; dark grayish brown (10YR 4/2) moist; weak, fine, granular structure; slightly hard, friable, nonsticky; common medium and fine roots; 5 percent gravel; moderately alkaline; clear, smooth boundary.

AC—7 to 20 inches, brown (10YR 5/3) sandy loam; dark brown (10YR 4/3) moist; common, medium, faint, dark grayish-brown (10YR 4/2) mottles; massive; slightly hard, friable, slightly sticky; few fine roots; 10 percent gravel; slightly calcareous; moderately alkaline; clear, smooth boundary.

C1ca—20 to 26 inches, grayish-brown (10YR 5/2) sandy loam; dark grayish brown (10YR 4/2) moist; many, medium, faint, gray (10YR 5/1) mottles; massive; slightly hard, friable, nonsticky; few fine roots; 5 percent gravel; strongly calcareous; moderately alkaline; clear, wavy boundary.

C2—26 to 60 inches, brown (10YR 5/3) heavy loamy sand; dark brown (10YR 4/3) moist; common, medium, faint, dark grayish-brown (10YR 4/2) mottles; massive; loose, nonsticky; 5 percent gravel; calcareous; moderately alkaline.

The A and AC horizons are grayish brown to dark grayish brown. Reaction is 7.9 to 8.4. Depth to the C horizon ranges from 18 to 25 inches. The C horizon contains thin (less than 4 inches thick) lenses of gravel in places. Reaction is 7.9 to 9.0.

**Hawksell sandy loam, 5 to 9 percent slopes (HoD).**—This soil is on colluvial-alluvial slopes and fans in the southwestern part of Chaffee County. Included with it in mapping are small areas of St. Elmo gravelly sandy loam, 3 to 9 percent slopes; Manhattan sandy loam, 3 to 9 percent slopes; and Rough broken land.

Surface runoff is rapid, and the hazard of erosion is moderate. Most of the acreage of this soil is irrigated. Alfalfa is the main crop, but such small grains as barley and oats are also grown. (Capability unit IVe-3, irrigated, VIe-3, nonirrigated; Sandy Bench range site)

#### **Keeldar Series**

The Keeldar series consists of deep, well-drained soils on high terraces. These soils formed in calcareous, gravelly, moderately coarse textured alluvium. Slopes range from 1 to 5 percent. Elevation ranges from 7,000 to 9,000 feet. The plant cover is grass and a few woody plants. The average annual precipitation is 11 to 15 inches. The average annual soil temperature is 46° F., and the average soil temperature in summer is 63°. The frost-free season is 60 to 100 days.

In a representative profile the surface layer is dark-brown gravelly sandy loam about 10 inches thick. The upper part of the underlying layer is dark grayish-brown gravelly sandy loam about 10 inches thick. The lower part of the underlying layer is brown and grayish-brown gravelly sandy loam that is strongly calcareous. It is underlain by gravel and cobbles at a depth of 55 inches. The soil is mildly alkaline in the upper 10 inches.

and moderately alkaline below that depth. The profile is calcareous throughout.

Permeability in these soils is rapid, and the available water capacity is low. Effective rooting depth is 60 inches or more.

Most areas of these soils are irrigated and are used for growing alfalfa and small grains.

Representative profile of Keeldar gravelly sandy loam, 1 to 5 percent slopes, 1,200 feet east of the northwest corner of sec. 3, T. 49 N., R. 8 E., Chaffee County:

A1—0 to 10 inches, brown (7.5YR 5/2) gravelly sandy loam; dark brown (7.5YR 3/2) moist; weak, fine, granular structure; slightly hard, friable, slightly sticky; common fine and medium roots; 30 percent gravel; slightly calcareous; mildly alkaline; clear, smooth boundary.

AC—10 to 20 inches, grayish-brown (10YR 5/2) gravelly sandy loam; dark grayish brown (10YR 4/2) moist; very weak, coarse, prismatic structure parting to weak, coarse, subangular blocky; hard, friable, slightly sticky; few fine and medium roots; 30 percent gravel; strongly calcareous; moderately alkaline; gradual, smooth boundary.

C1ca—20 to 43 inches, pale-brown (10YR 6/3) gravelly sandy loam; brown (10YR 5/3) moist; massive; hard, friable, slightly sticky; few fine roots; 35 percent gravel; strongly calcareous; moderately alkaline; gradual, smooth boundary.

C2ca—43 to 55 inches, light-gray (10YR 7/2) gravelly sandy loam; grayish brown (10YR 5/2) moist; massive; hard, very friable, slightly sticky; 30 percent gravel; very strongly calcareous; moderately alkaline; gradual, wavy boundary.

IIC—55 to 60 inches, gravel and cobbles.

The A horizon ranges from dark brown to very dark grayish brown. Content of coarse fragments ranges from 15 to 30 percent. Reaction is 7.4 to 8.4. The AC horizon ranges from dark brown to dark grayish brown. Reaction is 7.9 to 9.0. Depth to the IIC horizon ranges from 40 to more than 60 inches.

**Keeldar gravelly sandy loam, 1 to 5 percent slopes (KeC).**—This soil is on high terraces in the southern part of Chaffee County. The areas generally are oval in shape. Included with this soil in mapping are small areas of St. Elmo gravelly sandy loam, 1 to 3 percent slopes, and Manhattan sandy loam, 1 to 3 percent slopes and 3 to 9 percent slopes.

Surface runoff is slow, and the hazard of erosion is slight. Most of the acreage of this soil is irrigated and is used for growing alfalfa and small grains (fig. 8). (Capability unit IVe-3, irrigated, VIe-3, nonirrigated; Sandy Bench range site)

## Leadville Series

The Leadville series consists of deep, well-drained soils on mountains. These soils formed in stony and cobbly, medium-textured glacial outwash. Slopes range from 3 to 35 percent. Elevation ranges from 8,200 to 10,000 feet. The plant cover is lodgepole pine, Engelmann spruce, and subalpine fir. The average annual precipitation is 16 to 20 inches. The average annual soil temperature is 38° F., and the average soil temperature in summer is 46°. The frost-free season is 10 to 75 days.

In a representative profile the surface layer is very dark brown sandy loam about 1 inch thick. The subsurface layer is reddish-brown sandy loam that con-

tains about 10 percent stones and is about 7 inches thick. The subsoil is yellowish-red and reddish-brown clay loam that contains 50 to 70 percent cobbles and stones and is about 32 inches thick. The substratum is reddish-brown loam that contains 70 percent stones. It extends to a depth of 60 inches. The soil is medium acid in the surface and subsurface layers and slightly acid or neutral in the subsoil.

Permeability in these soils is moderately slow, and the available water capacity is moderate. Effective rooting depth is 60 inches or more.

These soils are used for woodland, grazing, and recreation.

Representative profile of Leadville sandy loam, 3 to 35 percent slopes, in a forested area 1.2 miles east of Highway 24 on Lake County Road No. 6, in the SW 1/4 of sec. 25, T. 9 S., R. 80 W., Lake County:

O2—1/2 inch to 0, organic mat consisting mainly of charred organic matter.

A1—0 to 1 inch, dark grayish-brown (10YR 4/2) sandy loam; very dark brown (10YR 2/2) moist; weak, fine, granular structure; soft, very friable, slightly sticky; many fine roots; medium acid; abrupt, smooth boundary.

A2—1 to 8 inches, pink (7.5YR 7/3) stony sandy loam; reddish brown (7.5YR 5/4) moist; moderate, thin, platy structure parting to weak, fine, subangular blocky; slightly hard, very friable, slightly sticky; common fine and medium roots; 10 percent stones and gravel; medium acid; clear, wavy boundary.

B&A—8 to 14 inches, reddish-brown (5YR 5/4) and pink (7.5YR 7/3) very stony sandy clay loam; reddish brown (5YR 4/4) and brown (7.5YR 5/4) moist; moderate, medium, subangular blocky structure; hard, friable, sticky; common coarse and medium roots; thin patchy clay films on faces of peds; 5 percent gravel; 15 percent stones, 10 to 30 inches in diameter; slightly acid; gradual, wavy boundary.

B21t—14 to 21 inches, yellowish-red (5YR 5/6) extremely stony clay loam; yellowish red (5YR 4/6) moist; moderate, medium, prismatic structure parting to moderate, medium, blocky; hard, friable, sticky; common fine and medium roots; thin continuous clay films on faces of peds; some pink (7.5YR 7/3) coatings of A2 material on faces of peds; 60 percent stones, 10 to 30 inches in diameter; slightly acid; clear, wavy boundary.

B22t—21 to 30 inches, reddish-brown (5YR 5/4) extremely stony clay loam; reddish brown (5YR 4/4) moist; moderate, medium and fine, subangular blocky structure; hard, friable, sticky; few medium and coarse roots; thin nearly continuous clay films on faces of peds; 70 percent stones; neutral; gradual, wavy boundary.

B3t—30 to 40 inches, reddish-brown (5YR 5/4) extremely stony clay loam; reddish brown (5YR 4/4) moist; weak, medium, subangular blocky structure; hard, friable, sticky; few fine and medium roots; few patchy clay films on faces of peds; 60 percent cobbles and stones, 6 to 30 inches in diameter; slightly acid; gradual, wavy boundary.

C—40 to 60 inches, reddish-brown (5YR 5/4) extremely stony loam; reddish brown (5YR 4/4) moist; massive; hard, very friable, slightly sticky; 70 percent stones and cobbles, 10 to 30 inches in diameter; neutral.

The A2 horizon is brown or reddish brown. Reaction is 5.6 to 6.5. The B2t horizon ranges from reddish brown to yellowish red or brown. It is sandy clay loam, clay loam, or clay loam modified by stones or cobbles. Content of coarse fragments exceeds 50 percent. Reaction is 6.1 to 7.3. Depth to the C horizon ranges from 30 to 45 inches. Uncomfortable strata of cobbles and gravel can occur below a depth of 40 inches in places.

**Leadville sandy loam, 3 to 35 percent slopes (LeE).—**This soil is on mountain slopes in the east-central part of Lake County. Included with it in mapping are small areas of Troutville gravelly sandy loam and small areas that have bedrock at a depth of less than 20 inches.

Surface runoff is medium to rapid, and the hazard of erosion is moderate. Most of this soil is forested with lodgepole pine and some ponderosa pine. Engelmann spruce and subalpine fir are at the higher elevations. This soil is used as range in areas that have been logged or burned. (Capability unit VIe-4, nonirrigated; woodland suitability group 1)

### Manhattan Series

The Manhattan series consists of well-drained soils on high terraces. These soils are moderately deep over sand, gravel, and cobbles. They formed in calcareous, gravelly, moderately coarse textured alluvium. Slopes range from 1 to 9 percent. Elevation ranges from 7,000

to 9,000 feet. The plant cover is grass and a small amount of woody plants. The average annual precipitation is 11 to 15 inches. The average annual soil temperature is 46° F., and the average soil temperature in summer is 63°. The frost-free season is 60 to 100 days.

In a representative profile the surface layer is very dark grayish-brown or dark-brown sandy loam about 16 inches thick. The underlying layer is very pale brown, strongly calcareous gravelly sandy loam that overlies sand, gravel, and cobbles at a depth of about 37 inches. The profile is neutral to moderately alkaline and is calcareous throughout.

Permeability in these soils is moderately rapid, and the available water capacity is low. Effective rooting depth is 60 inches or more.

Most of the acreage of these soils is irrigated and is used for growing hay, mainly alfalfa.

Representative profile of Manhattan sandy loam, 1 to 3 percent slopes, in an alfalfa field 1,900 feet north



**Figure 8.—**Alfalfa stubble on Keeldar gravelly sandy loam, 1 to 5 percent slopes. Contour ditch, on left, is a good method for controlling water in flood irrigation.

and 20 feet west of the southeast corner of sec. 36, T. 50 N., R. 8 E:

A11—0 to 4 inches, dark grayish-brown (10YR 4/2) sandy loam; very dark grayish brown (10YR 3/2) moist; weak, medium, crumb structure; slightly hard, very friable, slightly sticky when wet; many fine and medium roots; 5 percent cobbles; slightly calcareous; neutral; clear, smooth boundary.

A12—4 to 10 inches, dark-brown (7.5YR 4/2) sandy loam; dark brown (7.5YR 3/2) moist; very weak, medium, blocky structure; slightly hard, friable, slightly sticky; many fine and medium roots; 10 percent fine gravel; slightly calcareous; neutral; clear, smooth boundary.

A13—10 to 16 inches, brown (7.5YR 5/3) sandy loam; dark brown (7.5YR 3/3) moist; very weak, medium, sub-angular blocky structure; slightly hard, friable, slightly sticky; common fine and medium roots; 10 percent fine and medium gravel; slightly calcareous; mildly alkaline; clear, smooth boundary.

Cca—16 to 37 inches, very pale brown (10YR 8/3) gravelly sandy loam; very pale brown (10YR 7/3) moist; massive; hard, friable, slightly sticky; 25 percent gravel; very strongly calcareous; moderately alkaline; abrupt, smooth boundary.

IIC—37 to 60 inches, cobbles, gravel, and sand.

The A horizon ranges from dark brown to very dark grayish brown. Commonly, it is slightly calcareous to strongly calcareous. Reaction is 6.6 to 7.8. The A horizon is directly over the Cca horizon, which has a high content of lime. Depth to the Cca horizon ranges from 16 to 28 inches.

#### **Manhattan sandy loam, 1 to 3 percent slopes (McB).—**

This soil is on high terraces in the southwestern part of Chaffee County. It has the profile described as representative of the series. Included with this soil in mapping are small areas of St. Elmo gravelly sandy loam, 1 to 3 percent slopes. Also included are soils that are noncalcareous to a depth of 10 inches or more and are deeper over the layer of cobbles, gravel, and sand.

Surface runoff is slow, and the hazard of erosion is slight. Most areas of this soil are irrigated and are used as hayland. Alfalfa is the main crop. (Capability unit IVE-3, irrigated, VIe-3, nonirrigated; Sandy Bench range site)

#### **Manhattan sandy loam, 3 to 9 percent slopes (McD).—**

This soil is on high terraces in the southwestern part of Chaffee County. Included with it in mapping are small areas of St. Elmo gravelly sandy loam, 3 to 9 percent slopes. Also included are soils that are noncalcareous to a depth of 10 inches or more and are deeper over the layer of cobbles, gravel, and sand.

Surface runoff is medium, and the hazard of erosion is moderate. Most of the acreage of this soil is irrigated and is used as hayland. Alfalfa is the main crop (fig. 9). (Capability unit IVE-3, irrigated, VIe-3, nonirrigated; Sandy Bench range site)

### **Marsh**

Marsh (Mh) is a nearly level land type in Lake County. It is along the first bottoms of the main tributaries and side drainageways of the Arkansas River, the East Fork of the Arkansas River, Lake Creek, Tennessee Creek, Iowa Gulch, Half Moon Creek, and other streams. This mapping unit consists of extremely wet, mixed, medium-textured to coarse-textured soil material that has a water table at or near the surface

throughout the year. In most places a layer of organic matter or peat is at the surface. Small swamps and ponds are included in this mapping unit, which is subject to frequent overflow. Also included are small areas of Rosane loam, Newfork gravelly sandy loam, and Peat.

The plant cover is mostly willows, sedges, rushes, and cattails. It is of very little grazing value. Wildlife use the areas for winter feed and protection. (Capability unit VIIIw-1, nonirrigated)

### **Mine Pits and Dumps**

Mine pits and dumps (Mp) is a nearly level to very steep land type in the northeastern part of Lake County in the vicinity of Leadville. This land type consists of mine pits, which are excavations from which soil and geological material have been removed, and mine dumps, which are uneven accumulations or piles of waste rock from mining excavations or waste material from smelters.

Included with this unit in mapping are small areas of Tomichi sandy loam, Troutville gravelly sandy loam, and Bross gravelly sandy loam.

This land type has little or no value for farming and is considered wasteland. At present, it is valued as a tourist attraction. (Capability unit VIIIs-1, nonirrigated)

### **Newfork Series**

The Newfork series consists of poorly drained soils on low terraces. These soils are shallow over cobbles and gravel. They formed in gravelly, moderately coarse textured alluvium. Slopes range from 1 to 3 percent. Elevation ranges from 8,200 to 10,500 feet. The plant cover is sedges, rushes, and water-tolerant grasses. The average annual precipitation is 12 to 25 inches. The average annual soil temperature is 38° F., and the average soil temperature in summer is 46°. The frost-free season is 15 to 80 days.



Figure 9.—Cattle being winter fed on alfalfa stubble on Manhattan soils.

In a representative profile the surface layer is mottled, dark-brown gravelly sandy loam about 6 inches thick. The subsoil is mottled, dark-brown very gravelly sandy loam about 6 inches thick. Cobbles, gravel, and sand are at a depth of 12 inches. The profile is neutral throughout.

Permeability in these soils is rapid, and the available water capacity is low. Effective rooting depth is 60 inches or more. A seasonal high water table is at a depth of 0 to 1 foot.

Most of the acreage of these soils is in irrigated meadow.

**Representative profile of Newfork gravelly sandy loam, 1 to 3 percent slopes, in a hay meadow, 600 feet west and 50 feet north of the center of sec. 32, T. 9 S., R. 80 W., Lake County:**

O2—1½ inches to 0, partly decomposed organic material.

A1g—0 to 6 inches, brown (7.5YR 5/2) gravelly sandy loam; dark brown (7.5YR 3/2) moist; common, medium, distinct, dusky-red (2.5YR 3/2) mottles; weak, fine, granular structure; slightly hard, friable, nonsticky; many fine and medium roots; 25 percent gravel; neutral; clear, smooth boundary.

B2g—6 to 12 inches, brown (7.5YR 5/3) very gravelly sandy loam; dark brown (7.5YR 3/3) moist; many, medium, distinct, dusky-red (2.5YR 3/2) and dark-gray (2.5YR 4/1) mottles; weak, coarse, prismatic structure; slightly hard, friable, nonsticky; many fine and medium roots; 50 percent gravel; neutral; gradual, smooth boundary.

IICg—12 to 60 inches, cobbles, gravel, and sand.

Covering the soil surface is an organic mat that ranges from 1 to 3 inches in thickness. The A horizon is very dark brown or dark brown. Reaction is 6.6 to 7.3. Depth to mottling ranges from 1 to 6 inches. The B2g horizon ranges from dark brown to very dark grayish brown. It is 35 to 60 percent gravel and cobbles. Reaction is 6.6 to 7.3. Depth to the IICg horizon, which consists of cobbles, gravel, and sand, ranges from 10 to 18 inches. It is 60 to 90 percent cobbles and gravel.

**Newfork gravelly sandy loam, 1 to 3 percent slopes (NfB).**—This soil is on low terraces in Lake County. The areas are long and narrow. Included with this soil in mapping are small areas of Rosane loam and Marsh.

Surface runoff is slow, and the hazard of erosion is slight. Most areas of this soil are in meadow that is cut for hay and also is grazed early and late in the growing season. (Capability unit Vw-1, irrigated)

## Ouray Series

The Ouray series consists of deep, well-drained soils on high terraces. These soils formed in moderately coarse textured alluvium. Slopes range from 1 to 5 percent. Elevation ranges from 7,000 to 7,700 feet. The plant cover is bunchgrasses, such as Indian ricegrass and needle-and-thread. The average annual precipitation is 11 to 13 inches. The average annual soil temperature is 46° F., and the average soil temperature in summer is 64°. The frost-free season is 85 to 110 days.

In a representative profile the surface layer is dark-brown and very dark grayish-brown sandy loam about 10 inches thick. The upper part of the underlying layer is dark grayish-brown sandy loam about 15 inches thick. The lower part of the underlying layer is brown

sand that reaches to a depth of 60 inches or more. The profile is neutral throughout.

Permeability in these soils is moderately rapid, and the available water capacity is low. Effective rooting depth is 60 inches or more.

Most of the acreage of these soils is irrigated. The main crop is alfalfa. A small acreage is in barley and oats.

**Representative profile of Ouray sandy loam, 1 to 5 percent slopes, in an alfalfa field 0.1 mile north of the railroad crossing near the northwest corner of sec. 24, T. 50 N., R. 8 E., Chaffee County:**

Ap—0 to 7 inches, dark-brown (7.5YR 4/2) sandy loam; dark brown (7.5YR 3/2) moist; weak, fine, granular structure; slightly hard, friable, slightly sticky; many fine and medium roots; few scattered igneous pebbles; neutral; clear, smooth boundary.

A12—7 to 10 inches, dark grayish-brown (10YR 4/2) sandy loam; very dark grayish brown (10YR 3/2) moist; weak, fine, granular structure; hard, friable, slightly sticky; common fine and medium roots; 5 percent fine gravel; neutral; clear, smooth boundary.

AC—10 to 25 inches, brown (10YR 5/3) sandy loam; dark grayish brown (10YR 4/2) moist; massive; slightly hard, very friable, nonsticky; common fine and medium roots; 5 percent fine gravel; neutral; gradual, smooth boundary.

IIC—25 to 60 inches, pale-brown (10YR 6/3) sand; brown (10YR 5/3) moist; 5 percent fine gravel; noncalcareous; neutral.

The A horizon ranges from very dark grayish brown to very dark brown. Reaction is 6.6 to 7.8. The IIC horizon ranges from loamy coarse sand to sand. Gravel and cobbles are below a depth of 40 inches in places.

**Ouray sandy loam, 1 to 5 percent slopes (OrC).**—This soil is on high terraces in the southeastern part of Chaffee County. The areas are long and relatively wide. Included with this soil in mapping are small areas of Cotopaxi loamy sand and Adilis loam.

Surface runoff is slow, and the hazard of erosion is moderate. Most of the acreage of this soil is irrigated. Alfalfa is the main crop. A small acreage is in barley and oats. (Capability unit IVe-3, irrigated, VIe-3, non-irrigated; Sandy Bench range site)

## Ouray Series, Thick Surface Variant

The Ouray series, thick surface variant, consists of deep, well-drained soils on terraces. These soils formed in noncalcareous, stratified, moderately coarse textured and medium-textured alluvium. Slopes range from 1 to 3 percent. Elevation ranges from 7,200 to 8,000 feet. The average annual precipitation is 11 to 14 inches. The average annual soil temperature is 46° F., and the average soil temperature in summer is 64°. The frost-free season is 80 to 110 days.

In a representative profile the surface layer is very dark brown gravelly loam and fine gravelly sandy loam and very dark grayish-brown loam about 26 inches thick. The underlying layer is very dark grayish-brown, stratified sandy loam and loam that is massive and extends to a depth of 60 inches. The profile is mildly alkaline throughout.

Permeability in these soils is moderate, and the available water capacity is moderate. Effective rooting depth is 60 inches or more.



Almost all the acreage of these soils is used for irrigated crops and hay.

Representative profile of Ouray gravelly loam, thick surface variant, 1 to 3 percent slopes, in a cultivated field 770 feet south of cattleguard and 40 feet west of center of road in NW $\frac{1}{4}$  sec. 34, T. 14 S., R. 78 W., Chaffee County:

- Ap—0 to 8 inches, dark-brown (10YR 4/3) gravelly loam; very dark brown (10YR 2/2) moist; weak, medium, subangular blocky structure parting to weak, fine, granular; slightly hard, very friable, slightly sticky; many medium and fine roots; mildly alkaline; clear, smooth boundary.
- A12—8 to 20 inches, dark-brown (10YR 4/3) fine gravelly sandy loam; very dark brown (10YR 2/2) moist; weak, medium, subangular blocky structure; very hard, friable, slightly sticky; common medium and fine roots; mildly alkaline; clear, smooth boundary.
- A13—20 to 26 inches, dark-brown (10YR 4/3) loam; very dark grayish brown (10YR 3/2) moist; massive; hard, friable, slightly sticky; few fine roots; mildly alkaline; gradual, smooth boundary.
- C—26 to 60 inches, grayish-brown (10YR 5/2) sandy loam stratified with loam; very dark grayish brown (10YR 3/2) moist; massive; hard, friable, slightly sticky; few medium roots; mildly alkaline.

The A horizon ranges from very dark grayish brown to very dark brown in color. Reaction ranges from 7.2 to 7.8. Depth to parent material ranges from 20 to 60 inches or more. In places gravel and cobbles are at a depth of 40 inches or more.

**Ouray gravelly loam, thick surface variant, 1 to 3 percent slopes (O<sub>u</sub>B).**—This soil is on terraces that parallel the main river and streams in the central and northern parts of Chaffee County, generally east of the Arkansas River.

Included with this soil in mapping are small areas of Dominson gravelly sandy loam, 1 to 9 percent slopes. Southwest of Salida and southeast of Buena Vista, there are areas of included soils that are less than 40 inches deep over cobbles and gravel and are slightly calcareous within 12 inches of the surface. Also included are small areas of Ouray soils that have a surface layer of gravelly sandy loam.

Runoff is slow on this soil, and the hazard of erosion is slight. Most of the acreage is irrigated and used for crops, mainly alfalfa hay, potatoes, and small grains. (Capability unit IVe-3, irrigated, VIe-3, nonirrigated; Sandy Bench range site)

## Pando Series

The Pando series consists of well-drained soils on old, high terraces. These soils are moderately deep over cobbles and gravel. They formed in slightly acid outwash. Slopes range from 3 to 9 percent. Elevation ranges from 8,000 to 8,800 feet. The plant cover is ponderosa pine and an understory of grass. The average annual precipitation is 14 to 18 inches. The average annual soil temperature is 38° F., and the average soil temperature in summer is 53°. The frost-free season is 50 to 75 days.

In a representative profile the surface layer is very dark grayish-brown gravelly sandy loam about 8 inches thick. The subsurface layer is brown gravelly sandy loam about 8 inches thick. The subsoil is dark yellowish-brown very gravelly sandy loam that has blocky

structure and is about 14 inches thick. The substratum is yellowish-brown gravelly coarse sand, which is over sand, gravel, and cobbles at a depth of about 40 inches. The soil is medium acid in the surface layer and subsurface layer and grades to neutral below a depth of 30 inches.

Permeability in these soils is moderately rapid, and the available water capacity is low. Effective rooting depth is 60 inches or more.

These soils are used for woodland, grazing, and recreation.

Representative profile of Pando gravelly sandy loam, 3 to 9 percent slopes, in native plant cover, 1,000 feet east of the southwest corner of sec. 8, T. 15 S., R. 78 W., Chaffee County:

- A11—0 to 3 inches, grayish-brown (10YR 5/2) gravelly sandy loam; very dark grayish brown (10YR 3/2) moist; weak, medium, granular structure; slightly hard, friable, nonsticky; common medium and fine roots; medium acid; clear, smooth boundary.
- A12—3 to 8 inches, dark grayish-brown (10YR 4/2) gravelly sandy loam; very dark grayish brown (10YR 3/2) moist; weak, medium, granular structure; slightly hard, friable, nonsticky; common medium and fine roots; 30 percent gravel; medium acid; clear, smooth boundary.
- A2—8 to 16 inches, pale-brown (10YR 6/3) gravelly sandy loam; brown (10YR 5/3) moist; single grained; loose when dry and moist; common medium and fine roots; medium acid; clear, smooth boundary.
- B2t—16 to 30 inches, light yellowish-brown (10YR 6/4) very gravelly sandy loam; dark yellowish brown (10YR 4/4) moist; weak to moderate, fine, subangular blocky structure; hard, friable, slightly sticky; few fine common medium roots; 65 percent highly weathered granitic gravel that has coatings and bridges of clay; slightly acid; clear, smooth boundary.
- IIC1—30 to 40 inches, light yellowish-brown (10YR 6/4) weathered granitic gravel and coarse sand; yellowish brown (10YR 5/4) moist; loose when dry and moist; neutral; gradual, wavy boundary.
- IIC2—40 to 60 inches, gravel and cobbles of mixed origin.

The A horizon ranges from very dark grayish brown to very dark brown. Content of coarse fragments ranges from 15 to 25 percent. Reaction is 5.6 to 7.3. The A2 horizon ranges from pale brown to brown. Reaction is 5.6 to 7.3. The B2t horizon ranges from brown to dark yellowish brown. It ranges from very gravelly sandy loam to very gravelly light sandy clay loam that is 60 to 80 percent coarse fragments. Reaction is 5.6 to 7.3. Depth to the C horizon consisting of sand, gravel, and cobbles ranges from 20 to 40 inches.

**Pando gravelly sandy loam, 3 to 9 percent slopes (PaD).**—This soil is on old, high terraces in the central part of Chaffee County. The areas are generally large and as long as they are wide.

Included with this soil in mapping are small areas of Dominson gravelly sandy loam, 1 to 9 percent slopes, and long, narrow, ridgelike areas of Dominson gravelly sandy loam, 9 to 45 percent slopes. Also included are a few small areas of Pando soils that have a surface layer of gravelly loamy sand.

Surface runoff is slow to medium, and the hazard of erosion is moderate. This soil is mainly wooded with ponderosa pine, but a small acreage is irrigated and is used for growing hay. The wooded areas have an understory of grass, which is grazed. (Capability unit VIe-1, irrigated, VIe-4, nonirrigated; woodland suitability group 2)

## Peat

Peat (Pe) is a level to nearly level land type that occurs in small areas throughout Chaffee and Lake Counties. Most of the acreage is along first bottoms, but some of it is in swales on terraces.

This mapping unit is very poorly drained and has a high water table at the surface throughout most of the year. It consists of fibrous matter derived from rushes, sedges, grasses, and other plants that decayed in place. The thickness of this material ranges from 1 foot to more than 5 feet. The underlying material generally is stratified, grayish-green sand and gravel.

Because of excess water on the surface, Peat generally cannot be grazed in spring and summer but is grazed in fall when the water table has fallen. Improving drainage generally is not feasible. A few areas are used as a source of commercial peat moss. Peat is also used as wildlife habitat. (Capability unit VIIIw-1, nonirrigated)

## Pierian Series

The Pierian series consists of excessively drained soils on high terraces. These soils are very shallow to shallow over stones, boulders, and cobbles. They formed in stony and cobbly, coarse-textured outwash. Slopes range from 3 to 45 percent. Elevation ranges from 8,200 to 9,600 feet. The plant cover is cool-season grasses such as Arizona fescue, needlegrass, and mountain muhly. The average annual precipitation is 16 to 20 inches. The average annual soil temperature is 38° F., and the average soil temperature in summer is 53°. The frost-free season is 25 to 60 days.

In a representative profile the surface layer is dark-brown gravelly sandy loam about 5 inches thick. Stones and boulders on the surface range from a few to 25 percent. The underlying layer is dark-brown gravelly sandy loam about 4 inches thick. Boulders, stones, cobbles, gravel, and sand are present from a depth of 9 inches to a depth of 60 inches or more. The soil is slightly acid to a depth of 5 inches and neutral below that depth.

Permeability in these soils is very rapid, and the available water capacity is low. Effective rooting depth is 60 inches or more.

Most of the acreage of these soils is in native range and is used for grazing and recreation.

Representative profile of Pierian gravelly sandy loam, 3 to 9 percent slopes, in native grass, 0.25 mile west on left hand fork off of Chaffee County Road No. 63 in SW $\frac{1}{4}$  sec. 36, R. 79 W., T. 11 S., Chaffee County:

- A1—0 to 5 inches, dark-brown (7.5YR 4/2) gravelly sandy loam; dark brown (7.5YR 3/2) moist; very weak, medium, subangular blocky structure parting to moderate, fine, granular; slightly hard, friable, nonsticky; common fine and medium roots; slightly acid; clear, smooth boundary.
- AC—5 to 9 inches, brown (7.5YR 5/2) gravelly sandy loam; dark brown (7.5YR 3/2) moist; weak, coarse, subangular blocky structure; soft, very friable, nonsticky; 50 percent gravel, stones, and boulders; neutral; gradual, wavy boundary.
- C—9 to 60 inches, mixed igneous stones, boulders, cobbles, gravel, and sand.

The A horizon ranges from dark brown to very dark grayish brown. Reaction is 6.1 to 7.3. Content of gravel and cobbles ranges from 40 to 70 percent. Depth to mixed stones, boulders, cobbles, gravel, and sand ranges from 8 to 16 inches.

**Pierian gravelly sandy loam, 3 to 9 percent slopes (PgD).**—This soil is on high terraces in the northern part of Chaffee County and in the southern part of Lake County. Areas generally are oval shaped. This soil has the profile described as representative of the Pierian series. Included with it in mapping are small areas of Poncha gravelly sandy loam. Also included are areas of soils that have slopes of less than 3 percent and areas of soils that are slightly deeper than this soil.

Surface runoff is slow, and the hazard of erosion is slight. Most of the acreage of this soil is in range and is used for grazing livestock and for recreation. (Capability unit VIe-3, nonirrigated; Mountain Outwash range site)

**Pierian soils, 20 to 45 percent slopes (PIF).**—These soils are on glacial moraines in the northern part of Chaffee County and in the southern part of Lake County. The areas are long and narrow and generally are more than 160 acres in size. These soils have a profile similar to that described as representative of the series, but they have a larger percentage of cobbles, boulders, and stones on the surface and their surface layer is stony sandy loam in places.

Included with these soils in mapping are small areas of Gravelly alluvial land.

Surface runoff is medium, and the hazard of erosion is moderate. All of the acreage of these soils is in grass and is used as range. The grass cover is used for limited grazing, provides food and cover for wildlife, and gives protection to the watershed. (Capability unit VIIe-1, nonirrigated; Mountain Outwash range site)

## Placer Diggings and Tailings

Placer diggings and tailings (Pn) is a level to steep land type in the northern part of Chaffee County and throughout Lake County. Most of the mapped areas are in the vicinity of Granite Lake and Twin Lake.

The original soil was disturbed, overturned, and redeposited while miners were washing alluvial and glacial deposits for the recovery of gold. Field operations left a very uneven, rough, scarred surface. Slopes range from 0 to 65 percent. There is very little plant cover. These areas, for the most part, are wasteland. (Capability unit VIIIs-1, nonirrigated)

## Poncha Series

The Poncha series consists of deep, well-drained soils on alluvial fans and high terraces. These soils are shallow over gravel, cobbles, and sand. They formed in calcareous, gravelly, moderately coarse textured alluvium. Slopes range from 1 to 5 percent. Elevation ranges from 8,200 to 9,600 feet. The plant cover is cool-season grasses. The average annual precipitation is 16 to 20 inches. The average annual soil temperature is 38° F., and the average soil temperature in summer is 53°. The frost-free season is 25 to 60 days.

In a representative profile the surface layer is dark-brown gravelly sandy loam about 8 inches thick. Below this is a layer of pale-brown gravelly sandy loam that is massive and strongly calcareous and is about 12 inches thick. Next is a layer of yellowish-brown gravel, cobbles, and sand that extends to a depth of 60 inches. The soil is neutral in the surface layer and moderately alkaline in the underlying material.

Permeability in these soils is moderately rapid, and the available water capacity is low. Effective rooting depth is 60 inches or more.

Most of the acreage of these soils is in grass and is used for grazing. A small acreage is in irrigated grass that is grown for hay.

Representative profile of Poncha gravelly sandy loam, 1 to 5 percent slopes, in native grass, about 1.1 miles northwest of Granite in the NW $\frac{1}{4}$  sec. 36, R. 80 W., T. 11 S., Chaffee County:

A11—0 to 3 inches, dark-brown (7.5YR 4/2) gravelly sandy loam; dark brown (7.5YR 3/2) moist; moderate, fine, granular structure; slightly hard, very friable, nonsticky; many medium and fine roots; 20 percent fine gravel; neutral; clear, smooth boundary.

A12—3 to 8 inches, dark-brown (7.5YR 4/2) gravelly sandy loam; dark brown (7.5YR 3/2) moist; weak, medium, granular structure; hard, friable, nonsticky; common medium and fine roots; 25 percent fine gravel; neutral; clear, wavy boundary.

C1ca—8 to 20 inches, very pale brown (10YR 8/3) gravelly sandy loam; pale brown (10YR 6/3) moist; massive; very hard, friable, nonsticky; few fine roots; 30 to 40 percent gravel and cobbles; the coarse fragments are lime coated; strongly calcareous; moderately alkaline; clear, wavy boundary.

IIC2ca—20 to 60 inches, yellowish-brown (10YR 5/4) gravel, cobbles, and sand; moderate to strong accumulation of calcium carbonate, which occurs as fine, soft segregations and coatings on gravel and cobbles.

The A horizon ranges from very dark grayish brown to dark brown. Reaction is 6.6 to 7.3. The A horizon is calcareous to the surface in places. The IIC horizon of cobbles, gravel, and sand is at a depth ranging from 15 to 24 inches. Reaction is 7.3 to 9.0.

**Poncha gravelly sandy loam, 1 to 5 percent slopes (PoC).**—This soil is on high terraces in the northern part of Chaffee County and northwest of Granite in Lake County. Included with this soil in mapping are small areas of Pierian gravelly sandy loam, 3 to 9 percent slopes.

Surface runoff is slow, and the hazard of erosion is slight. Most areas of this soil are in native range and are used for grazing by livestock and wildlife. A small acreage is irrigated and is used to grow grass hay. (Capability unit VIe-1, irrigated, VIe-3, nonirrigated; Mountain Outwash range site)

## Rock Land

Rock land in the survey area is mapped as Rock land, 15 to 60 percent slopes, and in complexes with Gravelly land and with the Stecum soils.

Rock land, 15 to 60 percent slopes (RcF) is a land type that occurs along the eastern edge of the survey area from Salida to Riverside. It is associated with Rock outcrop. Rock land is 50 to 90 percent outcrops of rock and 10 to 50 percent very shallow soils. Shallowness is the most important soil characteristic. The

exposed rock consists of Pike's Peak granite with gneiss and schist, Silver Plume granite with gneiss and schist, trachyte, perlite, and dibase. These are low sediment-producing materials.

Access to this land type is limited by the topography. The plant cover is sparse; it is mainly scrubby pinyon pine and such grasses as blue grama, mountain muhly, and Indian ricegrass.

Surface runoff is rapid, but the hazard of erosion is only moderate. The available water capacity is low. The mapping unit is used for watershed, wildlife habitat, and very limited grazing. (Capability unit VIIIs-1, nonirrigated; woodland suitability group 3)

**Rock land-Gravelly land complex, 3 to 35 percent slopes (RgE).**—This complex is about 60 to 75 percent Rock land and 25 to 40 percent shallow and very shallow soils that formed in material weathered from granite, gneiss, or schist. It is in the southeastern part of Lake County and the northeastern part of Chaffee County. The two land types are in intricate patterns that are determined by the degree of bedrock weathering, recent erosion, and geological erosion. The complex is on steep mountainside slopes and high uplands that are dissected by drainageways. This gives the landscape a rolling appearance (fig. 10).

Except for slope, Rock land in this complex is similar to Rock land, 15 to 60 percent slopes. Gravelly land generally is variable in texture, depth, and kind of parent rock. In most places the profile is gravelly sandy loam. The uppermost few inches have been darkened by organic matter and are granular in structure. Bedrock is at a depth ranging from 8 to 20 inches.

Included with this complex in mapping are small areas of Ouray gravelly loam, thick surface variant, 1 to 3 percent slopes, that are in narrow drainageways.

All the acreage of this mapping unit is in native vegetation, except for bare outcrops in areas of Rock land. The complex is used for limited grazing of livestock, wildlife habitat, watershed, and recreation. (Capability unit VIIIs-1, nonirrigated; woodland suitability group 3. Rock land not in a range site; Gravelly land in Mountain Loam range site)

**Rock land-Stecum complex, 15 to 60 percent slopes (RkF).**—This mapping unit is on rough mountain slopes in the central part of Chaffee County, east of the Arkansas River in the vicinity of Buena Vista. Rock land and the Stecum soils are in areas closely intermingled, and it is impractical to show them separately at the scale used in mapping (fig. 11). About 75 to 85 percent of the complex is Rock land, and the remaining 15 to 25 percent is Stecum soils.

On the Stecum soils, surface runoff is medium and the hazard of erosion is moderate.

This complex is used for wildlife habitat, recreation, watershed, and, to a limited extent, livestock grazing. (Capability unit VIIIs-1, nonirrigated; woodland suitability group 3)

## Rock Outcrop

Rock outcrop (Ro) is a steep and very steep land type that occurs throughout the survey area. Bare bedrock makes up 90 percent or more of the mapping





**Figure 10.**—Landscape of Rock land-Gravelly land complex, 3 to 35 percent slopes. The soil material is very shallow and gravelly, and it supports only a sparse cover of plants.

unit, and there are many sheer bluffs, crags, and talus slides. Lack of roads and rough topography make accessibility difficult.

Most of the geological material in this land type is

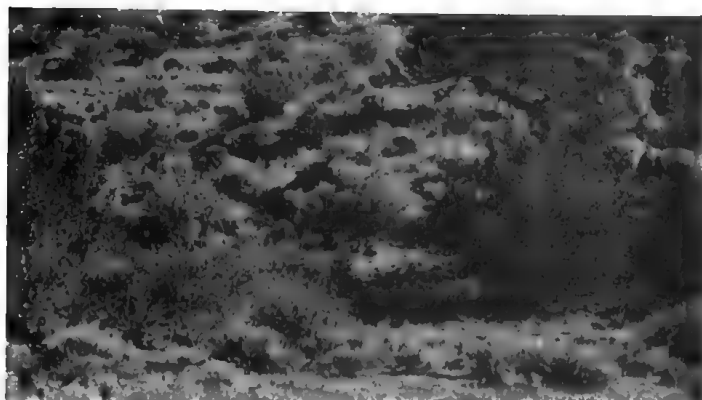
Pike's Peak granite with gneiss and schist, Silver Plume granite with gneiss and schist, trachyte, perlite, and dibase. These are very low sediment-producing materials.

The plant cover is very sparse. A few pinyon pines and other conifers grow in the crevices and cracks where fan materials and moisture accumulate. Rock outcrop is used for wildlife habitat, recreation, and watershed. (Capability unit VIIIs-1, nonirrigated)

### Rock Slides

Rock slides (Rs) is a steep to very steep land type in the eastern part of Lake County along the county line. It is present as talus below steep outcroppings of Precambrian rocks. This talus is the result of freezing and thawing, snowslides, and colluvial action. The rock fragments range in size from gravel to rocks several feet in diameter. Depth of accumulation ranges from a few feet to more than 50 feet, and little sorting has occurred. There is little or no plant cover.

This land type generally has a permafrost layer that acts as a frozen reservoir and yields water for use late in summer. (Capability unit VIIIs-1, nonirrigated)



**Figure 11.**—Landscape of Rock land-Stecum complex, 15 to 60 percent slopes. Areas of shallow soils and rock outcrops are intermingled.

## Rosane Series

The Rosane series consists of poorly drained soils in wet swales on uplands and in drainage channels on bottom lands. These soils are moderately deep over sand, gravel, and cobbles. They formed in moderately coarse textured, mixed alluvium. Slopes range from 1 to 5 percent. Elevation ranges from 8,200 to 10,500 feet. The plant cover is rushes, sedges, willows, and water-tolerant grasses. The average annual precipitation is 12 to 25 inches. The average annual soil temperature is 38° F., and the average soil temperature in summer is 46°. The frost-free season is 15 to 80 days.

In a representative profile a thin organic mat overlies the surface layer. The underlying surface layer is very dark-brown loam and black sandy loam, 17 inches thick, that has dark-brown mottles. The subsoil is very dark grayish-brown sandy loam, about 13 inches thick, that has many yellowish-brown mottles. The substratum is gravel, sand, and cobbles that extends to a depth of 60 inches. The profile is neutral throughout.

Permeability in these soils is moderately rapid, and the available water capacity is low. Effective rooting depth is 60 inches or more. A seasonal water table rises to the surface. Rosane soils are subject to frequent overflow.

Most of the acreage of these soils is flood-irrigated grassland and is used for grazing.

Representative profile of Rosane loam, 1 to 5 percent slopes, in a pasture, near the center of sec. 32, T. 9 S., R. 80 W., Lake County:

O1—6 inches to 0, organic mat; composed of roots and undecomposed organic materials.

A11g—0 to 6 inches, dark grayish-brown (10YR 4/2) loam; very dark brown (10YR 2/2) moist; common, fine, distinct, dark-brown (7.5YR 4/4) mottles; moderate, fine, granular structure; slightly hard, friable, slightly sticky; many fine roots; neutral; clear, smooth boundary.

A12g—6 to 17 inches, dark-gray (5Y 4/1) sandy loam; black (5Y 2/2) moist; many, medium, distinct, dark-brown (7.5YR 4/4) mottles; weak, fine, subangular blocky structure; slightly hard, friable, nonsticky; many fine and medium roots; neutral; gradual, smooth boundary.

B2g—17 to 30 inches, grayish-brown (10YR 5/2) heavy sandy loam; very dark grayish brown (10YR 3/2) moist; many, coarse, distinct, yellowish-brown (10YR 5/6) mottles; massive; slightly hard, friable, slightly sticky; common medium roots; neutral; smooth boundary.

IICg—30 to 60 inches, mixed gravel, cobbles, and sand; many, large, prominent, high-chroma mottles.

The A horizon ranges from very dark grayish brown to black in color and from sandy loam to loam in texture. Mottles range from few to many and from distinct to prominent. A contrasting IIC horizon of gravel and cobbles is at a depth of 20 to 40 inches.

**Rosane loam, 1 to 5 percent slopes (RtC).**—This soil is in upland swales and in drainage channels of the flood plains in all parts of Lake County. The areas generally are long and narrow because they follow old river and stream channels. Included with this soil in mapping are small areas of Newfork gravelly sandy loam and Marsh.

Nearly all the acreage of this soil is flood irrigated and is in pasture that is grazed by cattle. (Capability unit Vw-1, irrigated)

## Rough Broken Land

Rough broken land is mapped in two units in the Chaffee-Lake Area—Rough broken land and Rough broken land, cold.

Rough broken land (Ru) is a gently sloping to steep land type that consists of sediments of the Dry Union Formation. It is in the southern and central part of the survey area in Chaffee County. Rough broken land is made up of highly stratified, gray, brown, and pinkish-yellow silt; clay that has lenses of sand; and gravel and cobbles. The strata of these materials range from a few inches to many feet in thickness. The layers of deposition are not uniform and differ within short distances.

Most of this land is calcareous and has pockets of high lime accumulation. A thin cap of gravel and cobbles covers most of the surface. This land has been dissected by erosion and appears as long, fingerlike protrusions onto the valley floor. Near the bottom of the valley floor, there are isolated areas that are a result of more recent erosion. Much of the land is no longer a high sediment producer because of the gravel and cobbles on the surface.

Surface runoff is rapid, and the hazard of erosion is high. The plant cover is pinyon pine and juniper and an understory of blue grama, Indian ricegrass, mountain muhly, and other grasses. Included with this land type in mapping are small areas of Gravelly alluvial land, Badland, Hawksell sandy loam, Shrine clay loam, and Costilla gravelly sandy loam. (Capability unit VIIe-1, nonirrigated; woodland suitability group 3)

## Rough Broken Land, Cold

Rough broken land, cold (Rv) is a gently sloping to steep land type that consists of sediments of the Dry Union Formation. It is in the southern part of Lake County. Rough broken land, cold, is made up of Tertiary sediments that are highly stratified, gray, brown, and pinkish-yellow silt; clay that has lenses of sand; and gravel and cobbles. The strata of these materials range from a few inches to many feet in thickness. They are not uniform and differ within short distances.

Most of this land type is calcareous and has pockets of high lime accumulation. A cap of gravel and cobbles covers most of the areas. This land has been dissected by erosion and appears as long fingerlike protrusions onto the valley floor. Much of the land is no longer a high sediment-producing area because of the superficial cap of gravel and cobbles.

Surface runoff is rapid, and the hazard of erosion is high. The plant cover is native grasses. Included with this land type in mapping are areas of Pierian gravelly sandy loam and Badland.

This mapping unit is similar to Rough broken land, but it is at higher elevations, is in colder climate, and receives more precipitation annually. All of Rough broken land, cold, is in native grasses that are grazed by cattle and sheep. (Capability unit VIIe-1, nonirrigated)

## St. Elmo Series

The St. Elmo series consists of well-drained soils on high terraces. These soils are very shallow to shallow over cobbly and gravelly materials. They formed in calcareous, gravelly and cobbly, coarse-textured outwash. Slopes range from 1 to 45 percent. Elevation ranges from 7,000 to 9,000 feet. The plant cover is mainly blue grama, junegrass, and Indian ricegrass, but there is some pinyon pine and juniper on the upper part of slopes. The average annual precipitation is 11 to 15 inches. The average annual soil temperature is 46°F., and the average soil temperature in summer is 63°. The frost-free season is 60 to 100 days.

In a representative profile the surface layer is dark-brown gravelly sandy loam about 10 inches thick. The underlying layer is brown gravelly and cobbly loamy sand that is strongly calcareous and is about 10 inches thick. Lime-coated gravel and cobbles are below a depth of 20 inches. The profile is calcareous and moderately alkaline throughout.

Permeability in these soils is rapid, and the available water capacity is low. Effective rooting depth is 60 inches or more.

Some areas of St. Elmo soils are in native grass and are used for grazing. Other areas are irrigated and are used for growing hay, principally alfalfa.

Representative profile of St. Elmo gravelly sandy loam, 1 to 3 percent slopes, in native grass, about 200 feet north of terrace edge, 300 feet west and 50 feet south of airport hangar in sec. 10, T. 49 N., R. 8 E., Chaffee County:

A1—0 to 10 inches, dark-brown (7.5YR 4/2) gravelly sandy loam; dark brown (7.5YR 3/2) moist; weak, coarse, prismatic structure parting to weak, fine, granular; slightly hard, very friable, slightly sticky; common medium and fine roots; 20 percent gravel and cobbles; slightly calcareous; moderately alkaline; clear, smooth boundary.

C1ca—10 to 20 inches, pale-brown (10YR 6/3) gravelly and cobbly loamy sand; brown (10YR 5/3) moist; massive; very hard, friable, nonsticky; common fine and medium roots; strongly calcareous with many soft segregations of lime; moderately alkaline; gradual, wavy boundary.

Cca2—20 to 60 inches, gravel, cobbles, and sand; some lime coatings on undersides of gravel and cobbles.

Coarse fragments on the surface range from few to 15 percent. The A horizon ranges from dark brown to very dark grayish brown. Content of coarse fragments ranges from 15 to 25 percent. Reaction is 7.9 to 8.4. The C1ca horizon ranges from pale brown to brown. Content of cobbles and gravel ranges from 30 to 70 percent. Reaction is 7.9 to 8.4. Depth to gravel and cobbles ranges from 20 to 40 inches.

**St. Elmo gravelly sandy loam, 1 to 3 percent slopes (SeB).**—This soil is on high terraces in the southern part of Chaffee County between Salida and Maysville. Areas generally are long and narrow. This soil has the profile described as representative of the series. Included with it in mapping are small areas of Manhattan sandy loam, 1 to 3 percent slopes.

Surface runoff is slow, and the hazard of erosion is slight. About half the acreage of this soil is in native grass and is used for grazing livestock. The rest is in irrigated hay, mainly alfalfa. (Capability unit IVs-1, irrigated, VIe-3, nonirrigated; Dry Mountain Outwash range site)

**St. Elmo gravelly sandy loam, 3 to 9 percent slopes (SeD).**—This soil is on high terraces and valley side slopes in the southern part of Chaffee County between Salida and Maysville. This soil has a profile similar to that described as representative of the series, but it has steeper slopes. Included in mapping are small areas of St. Elmo gravelly sandy loam, 1 to 3 percent slopes, and St. Elmo gravelly sandy loam, 9 to 45 percent slopes.

Surface runoff is medium, and the hazard of erosion is moderate.

About two-thirds of the acreage of this soil is in native grass and is used for livestock grazing. The rest is in irrigated hay, mainly alfalfa. (Capability unit VIe-1, irrigated, VIe-3, nonirrigated; Dry Mountain Outwash range site)

**St. Elmo gravelly sandy loam, 9 to 45 percent slopes (SeF).**—This soil is on terrace edges in the southern part of Chaffee County between Salida and Maysville. Areas generally are long and very narrow in shape. This soil has a profile similar to that described as representative of the series, but it has steeper slopes.

Surface runoff is medium to rapid, and the hazard of erosion is moderate to high. This soil has a cover of grass that is used for limited grazing. Some areas have an overstory of pinyon pine and juniper. (Capability unit VIIe-1, nonirrigated; woodland suitability group 3; Dry Mountain Outwash range site)

## San Isabel Series

The San Isabel series consists of somewhat excessively drained soils on high terraces. These soils are shallow over gravel and cobbles. They formed in gravelly, moderately coarse textured outwash. Slopes range from 1 to 5 percent. Elevation ranges from 7,200 to 8,800 feet. The plant cover is bunchgrasses, such as junegrass, bunch bluegrass, and Indian ricegrass. The average annual precipitation is 11 to 16 inches. The average annual soil temperature is 46° F., and the average soil temperature in summer is 64°. The frost-free season is 75 to 100 days.

In a representative profile the surface layer is very dark grayish-brown stony sandy loam about 5 inches thick. The subsoil is dark-brown gravelly sandy loam about 14 inches thick. The substratum is gravel, cobbles, and boulders. The profile is neutral throughout.

Permeability in these soils is rapid, and the available water capacity is low. Effective rooting depth is 60 inches or more.

Most areas of these soils are in native grass and are used for grazing; a small acreage is used for urban expansion.

Representative profile of San Isabel stony sandy loam, 1 to 5 percent slopes, in native grass 50 feet north of Buena Vista city limits and 75 feet west of road in the NE¼ sec. 8, T. 14 S., R. 78 W., Chaffee County:

A1—0 to 5 inches, brown (10YR 5/3) stony sandy loam; very dark grayish brown (10YR 3/2) moist; moderate, fine, granular structure; slightly hard, friable, slightly sticky; common fine and medium roots; noncalcareous; 25 percent gravel; neutral; gradual, smooth boundary.

**B2t**—5 to 14 inches, brown (10YR 5/3) gravelly sandy loam; dark brown (10YR 3/3) moist; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky; common fine and medium roots; thin nearly continuous clay films on vertical and horizontal faces of peds; 50 percent cobbles and gravel; neutral; gradual, smooth boundary.

**B3**—14 to 19 inches, brown (10YR 5/3) gravelly sandy loam; dark brown (10YR 4/3) moist; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky; common medium and fine roots; thin patchy clay films on vertical faces of peds; 50 percent cobbles and gravel; neutral; gradual, wavy boundary.

**IIC**—19 to 60 inches, gravel, cobbles, boulders, and stones; coarse sand and sand in the interstices.

The A horizon ranges from very dark brown to very dark grayish brown. Stones on the surface range from 10 inches to 15 feet across. Reaction is 6.6 to 7.3. The B horizon ranges from very dark grayish brown to dark brown. Reaction is 6.6 to 7.3. Depth to an unconformable IIC horizon of gravel, cobbles, and boulders ranges from 10 to 20 inches.

**San Isabel stony sandy loam, 1 to 5 percent slopes (SsC).**—This soil is on high terraces adjacent to the Arkansas River in Chaffee County. The areas generally are long and narrow in shape. Included with this soil in mapping are small areas of Dominson gravelly sandy loam, 1 to 9 percent slopes. Also included are a few small areas of San Isabel soils that have a surface layer of cobbly or stony loamy sand.

Surface runoff is slow, and the hazard of erosion is slight. Most of the acreage of this soil is in native grass and is used for grazing of livestock and winter feed for wildlife. A small acreage is used for urban expansion. (Capability unit VII<sub>s</sub>–1, nonirrigated; Boulder Flats range site; woodland suitability group 3)

### Sawatch Series

The Sawatch series consists of poorly drained soils in upland swales and on flood plains throughout Chaffee County. These soils are moderately deep over sand and gravel. They formed in coarse-textured alluvium. Slopes range from 1 to 5 percent. Elevation ranges from 7,000 to 8,500 feet. The plant cover is rushes, sedges, and water-tolerant grasses. The average annual precipitation is 11 to 15 inches. The average annual soil temperature is 44° F., and the average soil temperature in summer is 62°. The frost-free season is 75 to 110 days.

In a representative profile a 6-inch mat of organic material overlies the surface layer. The surface layer is mottled, dark-brown and very dark gray sandy loam about 16 inches thick. The subsoil is dark-gray sandy loam that has many strong-brown mottles and is about 12 inches thick. The substratum is gravel, cobbles, and sand that reaches to a depth of about 60 inches. The profile is neutral throughout.

Permeability in these soils is moderately rapid, and the available water capacity is low. Effective rooting depth is 60 inches or more. A seasonal high water table is at a depth of 0 to 1 foot.

All the acreage of these soils is in irrigated grass that is grazed by livestock.

Representative profile of Sawatch sandy loam, 1 to 5 percent slopes, in a pasture 250 feet east and 200

feet south of the northwest corner of sec. 3, T. 49 W., R. 8 E., Chaffee County:

**O1**—6 inches to 0, organic mat consisting of undecomposed materials and roots; few cobbles on surface.

**A11g**—0 to 8 inches, dark-brown (10YR 4/3) sandy loam; dark brown (10YR 3/3) moist; few, fine, distinct, strong-brown (7.5YR 5/6) mottles; very weak, fine, subangular blocky structure; slightly hard, friable, slightly sticky; many fine and medium roots; neutral; gradual, smooth boundary.

**A12g**—8 to 16 inches, dark-gray (5Y 4/1) sandy loam; very dark gray (5Y 3/1) moist; many, large, prominent, brown (7.5YR 4/4) mottles; weak, fine, subangular blocky structure; slightly hard, friable, slightly sticky; many fine and medium roots; neutral; gradual, smooth boundary.

**B2g**—16 to 28 inches, gray (5Y 5/1) sandy loam; dark gray (5Y 4/1) moist; many, large, prominent, strong-brown (7.5YR 5/6) mottles; massive; hard, friable, slightly sticky; few fine roots; neutral; gradual, wavy boundary.

**IIC**—28 to 60 inches, gravel, cobbles, and sand.

The overlying organic mat is commonly 6 to 10 inches thick. The A horizon ranges from very dark gray to very dark brown. Mottling is to the surface; mottles range from few to many and from distinct to prominent. The contrasting IIC horizon of gravel and sand is at a depth of 20 to 40 inches.

**Sawatch sandy loam, 1 to 5 percent slopes (StC).**—This soil is in wet upland swales and flood-plain areas throughout Chaffee County. Areas generally are long and narrow and are along old stream channels. Included with this soil in mapping are small areas of Peat and Chaffee loam. Also included are small areas of Sawatch soils that have a surface layer of sandy clay loam.

Surface runoff is slow, and the hazard of erosion is slight. All the acreage of this soil is in irrigated native grass that is grazed by livestock. (Capability unit IV<sub>w</sub>–1, irrigated)

### Shrine Series

The Shrine series consists of deep, well-drained soils on valley side slopes and fans. These soils formed in moderately fine textured alluvium. Slopes range from 3 to 9 percent. Elevation ranges from 7,000 to 8,500 feet. The plant cover is blue grama, western wheatgrass, native bluegrass, and cactus. The average annual precipitation is 11 to 15 inches. The average annual soil temperature is 46° F., and the average soil temperature in summer is 64°. The frost-free season is 75 to 100 days.

In a representative profile the surface layer is very dark grayish-brown clay loam about 16 inches thick. The underlying layer is dark grayish-brown clay loam that reaches to a depth of 60 inches. The soil is moderately alkaline to strongly alkaline to a depth of 16 inches and is strongly alkaline below that depth. It is calcareous throughout.

Permeability in these soils is moderately slow, and the available water capacity is high. Effective rooting depth is 60 inches or more.

Most areas of these soils are irrigated, and alfalfa is the main crop. Small grains are grown in places.

Representative profile of Shrine clay loam, 3 to 9

percent slopes, in an alfalfa field in the NW $\frac{1}{4}$  sec. 7, T. 49 N., R. 8 E., Chaffee County:

Ap—0 to 9 inches, dark grayish-brown (10YR 4/2) clay loam; very dark grayish brown (10YR 3/2) moist; weak, fine, subangular blocky structure; slightly hard, friable, sticky; common fine and medium roots; few scattered pebbles; strongly calcareous; moderately alkaline; gradual, wavy boundary.

A12—9 to 16 inches, dark grayish-brown (10YR 4/2) clay loam; very dark grayish brown (10YR 3/2) moist; weak, coarse, subangular blocky structure; slightly hard, friable, sticky; many worm casts; 15 percent gravel; very strongly calcareous; moderately alkaline; clear, wavy boundary.

C—16 to 60 inches, grayish brown (2.5Y 5/2) clay loam; dark grayish brown (2.5Y 4/2) moist; massive; slightly hard, friable, sticky; few fine roots; very strongly calcareous; strongly alkaline.

The A horizon ranges from very dark grayish brown to very dark brown. Reaction is 7.9 to 8.4. The C horizon is stratified with lenses of loam or sandy loam in places, but its average texture is heavy loam to clay loam. In places there is an unconformable IIC horizon of gravel and cobbles between depths of 40 and 60 inches.

**Shrine clay loam, 3 to 9 percent slopes (SuD).**—This soil is on fans and valley side slopes in the southwestern

part of Chaffee County. The areas on valley side slopes generally are long and narrow. Included with this soil in mapping are small areas of Manhattan sandy loam, 3 to 9 percent slopes, and Gravelly alluvial land.

Surface runoff is medium to rapid, and the hazard of erosion is high. Most of the acreage of this soil is in irrigated crops, mainly alfalfa. Small grains are grown in places (fig. 12). (Capability unit IVe-1, irrigated, VIe-2, nonirrigated)

### Slickens

Slickens (Sw) is a land type in the northeastern part of Lake County near Leadville. The land consists of mill tailings from which the coarse material has been separated. The fine material is the residue from the processing of gold and silver. This material was floated into stilling basins and allowed to settle out. As a result, ponds were formed.

No vegetation grows on this land type. Slopes range from 0 to 25 percent. The land is considered wasteland and has value only as a tourist attraction. (Capability unit VIIIs-1, nonirrigated)



Figure 12.—Landscape of Shrine clay loam, 3 to 9 percent slopes. Most areas are irrigated and used mainly for alfalfa. Contour ditches are in background.



### Stecum Series

The Stecum series consists of moderately deep, well-drained soils on mountains. These soils formed in material that weathered from granite. Slopes range from 15 to 25 percent. Elevation ranges from 8,000 to 8,500 feet. The vegetation is a sparse cover of grass and an overstory of pinyon pine. The average annual precipitation is 11 to 15 inches. The average annual soil temperature is 44° F., and the average soil temperature in summer is 58°. The frost-free season is 30 to 80 days.

In a representative profile the surface layer is very dark brown sandy loam about 5 inches thick. The underlying layer is dark yellowish-brown and grayish-brown gravelly loamy sand about 27 inches thick. Granite bedrock is at a depth of 32 inches. The profile is neutral throughout.

Permeability in these soils is rapid, and the available water capacity is low. Effective rooting depth is 20 to 40 inches.

These soils are used for wildlife habitat, recreation, watershed, and, to a limited extent, livestock grazing.

In the Chaffee-Lake Area, soils of the Stecum series are mapped only in a complex with Rock land. A description of this complex is given under the heading "Rock land."

Representative profile of Stecum sandy loam, in an area of Rock land-Stecum complex, 15 to 60 percent slopes, in native grass 0.6 mile north of cattleguard at junction of Midland Scenic Road and U.S. Highway 24 and 130 feet west of Road 12 in NW¼ sec. 23, T. 14 S., R. 78 W., Chaffee County:

A1—0 to 5 inches, dark grayish-brown (10YR 4/2) sandy loam; very dark brown (10YR 2/2) moist; weak, fine and medium, granular structure; slightly hard, friable, slightly sticky; common fine and medium roots; 10 percent fine gravel; neutral; gradual, smooth boundary.

C1—5 to 20 inches, light yellowish-brown (10YR 6/4) gravelly loamy sand; dark yellowish brown (10YR 4/4) moist; massive; hard, friable, nonsticky; very few fine roots; 30 percent gravel; neutral; clear, irregular boundary.

C2—20 to 32 inches, light-gray (10YR 7/2) gravelly loamy coarse sand; grayish brown (10YR 5/2) moist; single grained; loose when dry and moist; 40 percent weathered granitic gravel; neutral; clear, smooth boundary.

R—32 to 40 inches, granite.

The A horizon ranges from dark grayish brown to very dark brown and from sandy loam to gravelly coarse sandy loam. Content of gravel ranges from 0 to 15 percent. The C horizon ranges from grayish brown to dark yellowish brown and from gravelly loamy sand to sand and gravel. Depth to bedrock ranges from 20 to 40 inches.

### Tigiwon Series

The Tigiwon series consists of well-drained soils that are shallow over sand and gravel. These soils are on old high terraces. They formed in gravelly, moderately coarse textured, calcareous outwash. Slopes range from 3 to 25 percent. Elevation is 7,500 to 9,000 feet. The plant cover is mid grasses and an overstory of pinyon pine and juniper. The average annual precipitation is 11 to 15 inches. The average annual soil temperature is 46° F., and the average soil temperature

in summer is 64°. The frost-free season is 60 to 85 days.

In a representative profile the surface layer is very dark grayish-brown cobbly sandy loam about 3 inches thick. The subsoil is dark-brown gravelly sandy clay loam about 5 inches thick. The substratum is brown gravelly coarse sandy loam that grades to gravel, cobblestones, and sand at a depth of about 18 inches. The soil is neutral in the surface layer but changes to moderately alkaline in the lower part.

Permeability in the Tigiwon soils is moderately rapid, and the available water capacity is low. Effective rooting depth is 60 inches or more.

Nearly all areas of these soils are used for wildlife habitat, recreation, watershed, and limited grazing for livestock.

Representative profile of Tigiwon cobbly sandy loam, in an area of Tigiwon-Turret cobbly sandy loams, 3 to 25 percent slopes, in NW¼ sec. 32, T. 50 N., R. 8 E., Chaffee County:

A1—0 to 3 inches, grayish-brown (10YR 5/2) cobbly sandy loam; very dark grayish brown (10YR 3/2) moist; weak, fine, subangular blocky structure parting to moderate, fine, granular; soft, very friable, slightly sticky; common medium and fine roots; 35 percent gravel and cobbles; neutral; clear, smooth boundary.

B2t—3 to 8 inches, brown (7.5YR 4/4) gravelly sandy clay loam; dark brown (7.5YR 4/4) moist; weak to moderate, medium, subangular blocky structure; hard, friable, slightly sticky; common medium and fine roots; very thin patchy clay films on vertical and horizontal faces of peds; streaks of very dark grayish brown (10YR 3/2) on vertical faces of peds; 35 percent gravel and cobbles; mildly alkaline; clear, wavy boundary.

C1ca—8 to 18 inches, very pale brown (10YR 7/3) gravelly coarse sandy loam; brown (10YR 5/3) moist; massive; hard, friable, nonsticky; few fine and medium roots; 40 percent gravel and cobbles; very strongly calcareous, coarse fragments coated with lime; moderately alkaline; gradual, irregular boundary.

IIC2ca—18 to 60 inches, gravel, cobbles, and sand; lime coatings on the coarse fragments decrease with increasing depth.

The A horizon ranges from very dark grayish brown to dark brown or very dark brown. The content of cobbles and gravel in this horizon ranges from 20 to 45 percent. Reaction is 6.6 to 7.3. The B2t horizon ranges from brown to dark yellowish brown or dark brown and from gravelly sandy clay loam to gravelly heavy loam. The content of gravel and cobbles in the B2t horizon ranges from 20 to 45 percent. Reaction is 7.4 to 7.8. The contrasting IIC horizon, which is below a depth of 18 inches, is 80 to 90 percent cobbles and gravel.

**Tigiwon-Turret cobbly sandy loams, 3 to 25 percent slopes (TgE).**—This mapping unit is between Poncha Springs and Maysville in the southern part of the survey area. It is about 45 percent Tigiwon cobbly sandy loam and 35 percent Turret cobbly sandy loam. These soils are on steep side slopes and terrace faces. Included with them in mapping, and making up 20 percent of the complex, are areas of gently sloping St. Elmo gravelly sandy loam on terraces and mesa tops (fig. 13).

The Tigiwon soil and the Turret soil each has the profile described as representative for its respective series.

Runoff is medium to rapid, and the hazard of erosion is moderate. Nearly all of the complex is in native

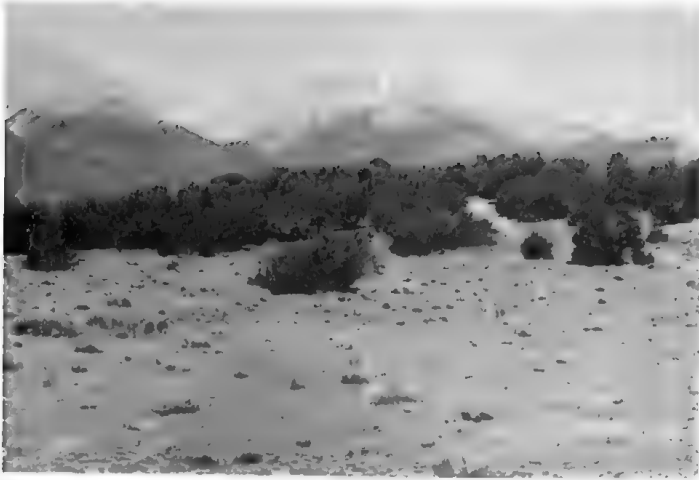


Figure 13.—Landscape of Tigiwon-Turret cobbly sandy loams, 3 to 25 percent slopes. St. Elmo gravelly sandy loam is in foreground, and the steeper Tigiwon and Turret soils are under pinyon pine in background.

plants and is used for wildlife habitat, watershed, recreation, and limited grazing for livestock. (Capability unit VIIe-1, nonirrigated; woodland suitability group 3)

### Tomichi Series

The Tomichi series consists of deep, somewhat excessively drained soils on terraces and uplands. These soils formed in gravelly and cobbly, coarse-textured outwash. Slopes range from 5 to 25 percent. Elevation ranges from 8,200 to 10,500 feet. The plant cover is ring muhly, fescues, and big sagebrush. The average annual precipitation is 16 to 22 inches. The average annual soil temperature is 38° F., and the average soil temperature in summer is 46°. The frost-free season is 10 to 75 days.

In a representative profile the surface layer is dark-brown sandy loam about 7 inches thick. Next is a layer of dark-brown gravelly sandy loam about 6 inches thick. Below this is dark yellowish-brown gravelly sand and cobbles that extends to a depth of 60 inches or more. The soil is medium acid to a depth of 13 inches and slightly acid below that depth.

Permeability in these soils is rapid, and the available water capacity is low. Effective rooting depth is 60 inches or more.

All of the acreage of this soil is in native grass and is used for livestock grazing, wildlife habitat, and recreation.

Representative profile of Tomichi sandy loam, 5 to 25 percent slopes, in native grass 100 feet south of Colorado Highway 91 in the northeast corner of NW $\frac{1}{4}$  sec. 33, R. 79 W., T. 8 S., Lake County:

A1—0 to 7 inches, brown (7.5YR 4/2) sandy loam; dark brown (7.5YR 3/2) moist; weak, medium, granular structure; slightly hard, friable, slightly sticky; many fine and medium roots; 10 percent gravel; medium acid; clear, wavy boundary.

AC—7 to 13 inches, dark-brown (10YR 4/3) gravelly sandy loam; dark brown (10YR 3/3) moist; massive;

slightly hard, very friable, slightly sticky; many fine and medium roots; 30 percent cobbles and gravel; medium acid; clear, wavy boundary.

C—13 to 60 inches, yellowish-brown (10YR 5/4) gravelly sand mixed with cobbles; dark yellowish brown (10YR 4/4) moist; slightly acid.

The A horizon ranges from dark brown to very dark brown. Reaction is 5.6 to 6.5. The AC horizon ranges from dark brown to dark yellowish brown. Content of gravel and cobbles ranges from 15 to 35 percent. Reaction is 5.6 to 6.5. Depth to the C horizon ranges from 10 to 18 inches. Reaction is 6.0 to 6.5.

### Tomichi sandy loam, 5 to 25 percent slopes (ToE).—

This soil is on uplands and terraces in the northeastern part of Lake County near Leadville. Areas generally are oval in shape and more than 40 acres in size. Included with this soil in mapping are small areas of Troutville gravelly sandy loam and small areas that have a high content of cobbles and gravel.

Surface runoff is slow, and the hazards of soil blowing and water erosion are moderate. All areas of this soil are in native grass and are used for livestock grazing, wildlife habitat, and recreation. (Capability unit VIe-5, nonirrigated; Subalpine Loam range site)

### Troutville Series

The Troutville series consists of deep, well-drained soils on mountains. These soils are moderately deep over sand, stones, cobbles, and gravel. They formed in gravelly, moderately coarse textured glacial till. Slopes range from 3 to 35 percent. Elevation ranges from 8,200 to 10,500 feet. The plant cover is lodgepole pine, Engelmann spruce, and subalpine fir. The average annual precipitation is 18 to 25 inches. The average annual soil temperature is 38° F., and the average soil temperature in summer is 46°. The frost-free season is 10 to 60 days.

In a representative profile the surface layer is about 2 inches of very dark grayish-brown gravelly sandy loam. The subsurface layer is about 18 inches of grayish-brown and yellowish-brown gravelly and very gravelly sandy loam. The subsoil is brown sandy loam that has lamellae of clay loam and is 60 percent stones. It is about 20 inches thick. The substratum is stones, cobbles, gravel, and sand. The soil is slightly acid to a depth of 14 inches and is neutral below that depth.

Permeability in these soils is moderately rapid, and the available water capacity is low. Effective rooting depth is 60 inches or more.

These soils are used for wildlife habitat, watershed, and recreation.

Representative profile of Troutville gravelly sandy loam, 3 to 35 percent slopes, in a wooded area in NE $\frac{1}{4}$  sec. 32, T. 8 S., R. 79 W., Lake County:

O—1 inch to 0, litter of pine needles.

A1—0 to 2 inches, dark grayish-brown (10YR 4/2) gravelly sandy loam; very dark grayish brown (10YR 3/2) moist; weak, fine, granular structure; slightly hard, very friable, slightly sticky; few coarse and medium roots; 20 percent gravel; slightly acid; clear, smooth boundary.

A2—2 to 14 inches, pale-brown (10YR 6/3) and light yellowish-brown (10YR 6/4) gravelly sandy loam; grayish brown (10YR 5/3) and yellowish brown (10YR 5/4) moist; weak, thin, platy structure parting to weak,

fine, granular; slightly hard, very friable, non-sticky; few coarse to fine roots; 20 percent gravel; slightly acid; clear, wavy boundary.

A&B—14 to 20 inches, light yellowish-brown (10YR 6/4) very gravelly sandy loam; yellowish brown (10YR 5/4) moist; lenses of yellowish-brown (10YR 5/4) sandy clay loam; dark yellowish brown (10YR 4/4) moist; weak, medium, subangular blocky structure; slightly hard, very friable, nonsticky; few medium and fine roots; 60 percent cobbles, stones, and gravel; neutral; clear, wavy boundary.

B2t—20 to 40 inches, yellowish-brown (10YR 5/4) to brown (7.5YR 5/4) extremely stony sandy loam and thin, discontinuous lamellae of sandy clay loam and clay loam; yellowish brown (10YR 5/4) moist and brown (7.5YR 4/4) moist; weak, medium, subangular blocky structure; slightly hard, very friable, slightly sticky; few fine and medium roots; thin, nearly continuous clay films on ped faces; 60 percent stones; neutral; diffuse, irregular boundary.

C—40 to 60 inches, stones, cobbles, gravel, and sand.

The A2 horizon ranges from grayish brown to yellowish brown. Content of coarse fragments ranges from 15 to 40 percent. Reaction is 6.1 to 7.3. The B2t horizon ranges from yellowish brown to dark brown. Reaction is 6.1 to 7.3. Lamellae in the B2t horizon range from ¼ inch to 1 inch in thickness and from heavy sandy loam to clay loam.

**Troutville gravelly sandy loam, 3 to 35 percent slopes (TrE).**—This soil is on glacial deposits on mountains in the northern part of Chaffee County, north of Clear Creek Reservoir and west of the Arkansas River, and in all parts of Lake County. The areas generally have northerly exposures and generally are larger than 160 acres in size. Included with this soil in mapping are small areas of Pierian soils and Rock outcrop.

Surface runoff is medium to rapid, and the hazard of erosion is moderate. This soil is used for wildlife habitat, watershed, and recreation. (Capability unit VIe-4, nonirrigated; woodland suitability group 1)

## Turret Series

The Turret series consists of deep, well-drained soils on alluvial fans and valley side slopes. These soils formed in cobbly, moderately coarse textured alluvium. Slopes range from 3 to 25 percent. Elevation ranges from 7,500 to 9,000 feet. The plant cover is mid grasses and an overstory of pinyon pine and juniper. The average annual precipitation is 11 to 15 inches. The average annual soil temperature is 46° F., and the average soil temperature in summer is 64°. The frost-free season is 60 to 85 days.

In a representative profile the surface layer is very dark grayish-brown cobbly sandy loam about 7 inches thick. The subsoil is dark-brown cobbly sandy clay loam and dark yellowish-brown cobbly sandy loam about 23 inches thick. The substratum, extending to a depth of 60 inches, is dark yellowish-brown sandy loam that is more than 70 percent stones, cobbles, and gravel. The profile is neutral throughout.

Permeability in these soils is moderate, and the available water capacity is low. Effective rooting depth is 60 inches or more.

Nearly all the acreage of Turret soils is in native grass and an overstory of pinyon pine and juniper. These soils are used for wildlife habitat, recreation, watershed, and limited livestock grazing.

In the Chaffee-Lake Area, soils of the Turret series are mapped only in a complex with Tigiwon soils. A description of this complex is given under the heading "Tigiwon Series."

Representative profile of Turret cobbly sandy loam, in an area of Tigiwon-Turret cobbly sandy loams, 3 to 25 percent slopes, 150 feet east of Forest Service road and 650 feet east and 1,750 feet south of the northwest corner of sec. 25, T. 50 N., R. 7 E., Chaffee County:

A1—0 to 7 inches, grayish-brown (10YR 5/2) cobbly sandy loam; very dark grayish brown (10YR 3/2) moist; weak, thin, platy structure; slightly hard, friable, slightly sticky; common fine and medium roots; 20 percent cobbles and gravel; neutral; gradual, smooth boundary.

B2t—7 to 16 inches, brown (10YR 5/3) cobbly sandy clay loam; dark brown (10YR 4/3) moist; moderate, medium, subangular blocky structure; hard, very friable, sticky; common medium and fine roots; thin continuous clay films on vertical and horizontal faces of peds; 30 percent cobbles and gravel; neutral; gradual, wavy boundary.

B3t—16 to 30 inches, light yellowish-brown (10YR 6/4) cobbly sandy loam; dark yellowish brown (10YR 4/4) moist; weak, medium to fine, subangular blocky structure; slightly hard, friable; slightly sticky; few medium and fine roots; few, thin, patchy clay films on faces of peds; 40 percent cobbles and gravel; neutral; gradual, wavy boundary.

C—30 to 60 inches, very pale brown (10YR 7/4) cobbly sandy loam; dark yellowish brown (10YR 4/4) moist; massive; slightly hard, friable, nonsticky; 70 percent stones, cobbles, and gravel; neutral.

The A horizon ranges from dark brown to very dark grayish brown. Content of gravel and cobbles ranges from 20 to 35 percent. Reaction is 6.6 to 7.3. The B2t horizon ranges from dark brown to dark yellowish brown and from gravelly or cobbly sandy loam to gravelly or cobbly sandy clay loam. Reaction is 6.6 to 7.3.

## Wet Alluvial Land

Wet alluvial land (Wo) is a nearly level to gently sloping land type on first bottoms adjacent to the Arkansas River and its main tributaries, such as the South Fork of the Arkansas River, Cottonwood Creek, Chalk Creek, and Brown's Creek. This land was formed by the meandering of rivers and streams.

This land consists of gravel and sand bars and of wet, stratified, medium-textured to coarse-textured soil materials. The kind of material and the way it was deposited vary considerably within short distances. These areas are subject to overflow from the Arkansas River and its tributaries, and they have a fluctuating water table between the surface and a depth of 2 feet.

The plant cover in Chaffee County is mainly cottonwoods, willows, and an understory of grass (fig. 14).

Wet alluvial land in Lake County is along the Arkansas River. It is similar to that in Chaffee County, but willows grow in thick stands and there are no cottonwood trees because of the cold climate. Slopes range from 0 to 5 percent.

Included with this unit in mapping are small areas of Marsh.

Wet alluvial land is not suitable as range but can be grazed to a limited extent. It provides good cover for wildlife. (Capability unit VIIw-1, nonirrigated)





**Figure 14.**—Wet alluvial land. The vegetation is mainly cottonwoods, willows, and grasses. This area provides good cover for wildlife.

### ***Use and Management of the Soils***

This section consists of several parts. The first part explains the capability grouping used by the Soil Conservation Service. Next, there are discussions on the management of irrigated soils, the irrigated capability units of the survey area, and the predicted yields of irrigated crops grown on the soils of those units. This is followed by a discussion of the nonirrigated capability units. Also given is management of the soils for range, woodland, wildlife, and engineering works.

#### **Capability Grouping**

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when used for field crops, the risk of damage when they are so used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope,

depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to horticultural crops or other crops requiring special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, forest trees, or engineering.

In the capability system, the kinds of soils are grouped at three levels: the capability class, subclass, and unit. These are discussed in the following paragraphs.

**CAPABILITY CLASSES**, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

Class I soils have few limitations that restrict their use. (None in Chaffee-Lake Area)

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices. (None in Chaffee-Lake Area)

Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both. (None in Chaffee-Lake Area)

Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife.

Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife.

Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture or range, woodland, or wildlife.

Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife, water supply, or to esthetic purposes.

**CAPABILITY SUBCLASSES** are soil groups within one class; they are designated by adding a small letter *e*, *w*, *s*, or *c*, to the class numeral for example, IVe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife, or recreation.

**CAPABILITY UNITS** are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IVe-1 or VIe-2. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

In the following pages the capability units in the Chaffee-Lake Area are described and suggestions for the use and management of the soils are given.

In this survey the soils are first classified according to their capability when irrigated, and then according to their capability without irrigation. The names of the soil series represented in a capability unit are named in the description of the capability unit, but this does not mean that all the soils of a given series appear in the unit. To find the names of all the soils in any given capability unit, refer to the "Guide to Mapping Units" at the back of this survey.

### Management of Irrigated Soils

There are about 24,000 acres of irrigated soils in the survey area. Nearly all of this acreage is irrigated by direct flow from streams that originate in the survey area. There is an adequate early supply of water, but often the supply is gone early in the summer. Crop yields are reduced because storage or reservoir water is not available during the summer and fall months. This lack of late water leads to excessive irrigation in the spring and early in summer.

Most of the irrigated soils are used to produce alfalfa or grass-clover hay for winter feeding in cattle or sheep enterprises. Some of the soils in the northern part of the survey area are too cold to grow other crops. An increasing acreage is being used for pasture to supplement grazing allotments or to take grazing pressure off of range. A small amount of oats and barley, most of which is harvested for hay, is grown when the soil is being readied to seed back to hay or pasture.

Although the irrigated acreage is not large, it is important to the economy of the survey area. The hay produced is necessary to carry base herds through the winter months. The meadows are used for pasture and for winter-feed areas. Irrigated soils furnish late and early grazing when range should not be used. Generally, cattle that are grass fat from grazing pastures and meadows are marketed in the fall. Irrigated meadows are most essential to ranching in this area. Without them, most ranchers would find it difficult to continue present operations.

The main problems in managing irrigated soils of this area are the short growing season, an inadequate supply of water for irrigation late in the season, inefficient use of irrigation water, and low production on meadows and pastures. Except in irrigation ditches, along stream channels, and during periods when stands of hay are being established, erosion is not a major problem. Usually the soils are protected by grass and clover roots. Simple management, after plowing out the sod, can be easily applied to control washing or blowing of the soil.

Excessive irrigation in spring, when an abundance of water is available, leaches out needed plant nutrients, makes fertilizing ineffective, and discourages the more desirable plants. It also keeps the soil cold and reduces plant growth. Excessive irrigation encourages the growth of sedges and rushes, and it can cause bogs or seeps that are difficult to pasture or cut for hay.

All of these problems are interdependent. One problem can add to, or create, another problem. A program is best that takes into consideration all of the problems and that outlines a plan to systematically solve each in its proper order. The following practices help to obtain optimum use of irrigation water, maintain or increase production of desirable plants, and control erosion.

The primary uses of irrigated soils are for cultivated crops, pasture, and hay. The conservation needs of irrigated soils can, at times, be better treated by changing soil use from cropland, where the soils frequently are cultivated and left bare, to permanent pasture or hay and by applying simple management practices. Cropland, however, is not the primary land use in this area.

Irrigation water management entails irrigating without excessive erosion according to crop needs and the soil's ability to receive and store water. Pasture and hayland generally are irrigated by *corrugations* (small furrows) or by controlled flooding from gradient laterals (*contour ditches*) at intervals down the slope. As steepness of the slope increases, or as the soil becomes more erodible, the length of run must be shortened, and the amount of irrigation water applied must be reduced to control erosion and to increase irrigation efficiency. For nearly level, more uniform slopes, border irrigation is one of the more efficient methods of applying irrigation water. The water is flooded between small dikes across the field. This method requires a relatively large head of water, depending on the width and length of the borders and the water intake rate of the soil.

Any type of "on-off" irrigation is superior to the continuous irrigation practiced on some meadow soils. The soil then has a chance to aerate and warm up, and this encourages the growth of better grasses. With proper irrigation methods and resultant better plant composition, the pastures and meadows will respond to fertilizer and proper grazing use and will become consistently more productive.

Reservoirs are needed to store excess spring runoff for use late in summer and in fall. Until these reservoirs are built, smaller individual ranch reservoirs permit accumulating the flows in small streams or ditches into usable irrigation heads. Such reservoirs can also be used to store water until it is needed, thus eliminating one of the reasons given for continuous irrigation.

Irrigation by properly designed sprinkler systems is an efficient method of applying irrigation water, especially for establishing new pasture and meadow plantings.

Nearly all of the irrigated soils are used for pasture or hay. Where fields in permanent grass for hay or pasture are renovated or plowed, the soils are often seeded to oats or barley. This gives the sod time to decompose, and the soil surface can be smoothed before reseeding.

Fertilizers, especially nitrogen and phosphate, are needed for high-producing meadows and pasture. Nitrogen can be used every year or during years of extra moisture. Phosphate generally is applied during renovation periods or before seeding.

The most successful plantings for pasture or hay are made on well-prepared, firmly packed soil. If water is available, seeding in August and September helps deter weed growth and shortens the time for planting establishment. Where water for fall irrigation is not available, seeding can be done in the spring. Phosphate, especially needed for clover or alfalfa, should be applied during seedbed preparation, or prior to seeding.

Nitrogen can be applied after the grass is up. It should also be applied annually to maintain plant vigor and composition throughout the life of the planting. If an old stand of pasture or hay has been plowed up, growing of oats or barley for 1 or 2 years allows for control of sleepy grass and other weeds while giving some production. Smoothing of the soil surface to facilitate the control of irrigation water can also be accomplished at this time. Good, clean stubble makes an almost ideal seedbed that generally requires no special treatment. Peaty soils can require special working to make a satisfactory seedbed.

Smooth brome, intermediate wheatgrass, timothy, meadow fescue, tall fescue, and orchardgrass are adapted grasses to seed for pasture or hay. Alfalfa, in the southern part of the survey area, and red clover, alsike clover, and Ladino clover are productive legumes that are adapted to the area. Drilling the seed with a grass or grain drill at a depth of about 1 inch gives better stands.

Grass and grass-legume mixtures for pasture require proper use and management for good production. Stubble or leaf heights generally are used to decide when a pasture is ready for use, or when it is time to stop or rotate use. Pasture should have at least a 4-inch growth before grazing starts, and a 3-inch stubble should be left at all times to help maintain healthy productive plants and reduce thinning and winterkill. A 3-inch stubble helps to minimize erosion and to spread irrigation water. Dragging, smoothing, renovation, and overseeding are used to maintain smooth pastures and meadows and to maintain good plant composition.

Leveling or land smoothing, weed control, irrigation pipelines, checks, drops, turnouts, and diversions are practices and structures that may be needed or desirable on any of the irrigated soils. Water-storage and head-stabilizing reservoirs help supply late-season irrigation water. Drainage, where outlets are available, is practical and needed in small areas of soils on terraces and in upland swales. The need for drainage can commonly be avoided by improving the irrigation system and water management.

Following are descriptions of the irrigated capability units in the survey area.

#### CAPABILITY UNIT IV<sub>a</sub>-1, IRRIGATED

Shrine clay loam, 3 to 9 percent slopes, is the only soil in this capability unit. It is a deep, well-drained soil that has a surface layer and underlying layer of clay loam. The average annual precipitation is 11 to 15 inches, and the frost-free season is 75 to 100 days.

Permeability in this soil is moderately slow. Runoff is medium to rapid, and the hazard of erosion is high.

Gullies form in places. Available water capacity is high. Effective rooting depth is 60 inches or more.

Most of the acreage is used for hay and pasture, to which the soil is well suited. Oats and barley are grown mainly as nurse crops with hay seedings. Adapted plants for pasture and hay are smooth brome, intermediate wheatgrass, orchardgrass, timothy, alfalfa, red clover, alsike clover, and Ladino clover.

Suitable methods of irrigation are the corrugation, contour-ditch, and sprinkler methods. Erosion is controlled by ditches that are closely spaced to permit respreeding the water before it accumulates. Small heads of water should be used to minimize erosion while irrigating. This soil can be leveled to increase irrigation efficiency and to reduce the hazard of erosion. Good management of pasture or hayland is needed to maintain good stands and vigorous growth. Legume crops respond to additions of phosphorus. Where legumes are scarce or absent in stands of hay, small grains and grasses respond to annual applications of nitrogen.

#### CAPABILITY UNIT IVc-2, IRRIGATED

Blanyon clay loam, 1 to 3 percent slopes, is the only soil in this capability unit. It is a deep, well-drained soil that has a surface layer of clay loam and a subsoil of silty clay loam. The average annual precipitation is 10 to 14 inches, and the frost-free season is 85 to 110 days.

Permeability in this soil is slow. Runoff is slow, and the hazard of erosion is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more.

This soil is used for hay, permanent pasture, and small grain. Oats and barley are grown mainly as a companion crop with new seedings of plants for hay. Adapted grasses for pasture and hay are smooth brome, intermediate wheatgrass, orchardgrass, timothy, and fescue. Adapted legumes are alfalfa, alsike clover, Ladino clover, and red clover.

Suitable methods of irrigation are the furrow, corrugation, border, contour-ditch, and sprinkler methods. This soil can be leveled to increase irrigation efficiency and to reduce the hazard of erosion.

Legume crops respond to additions of phosphorus. Where legumes are scarce or absent in stands of pasture or hay, small grains and grasses respond to annual applications of nitrogen.

#### CAPABILITY UNIT IVc-3, IRRIGATED

This capability unit consists of well-drained soils that are moderately deep and deep over sand, gravel, and cobbles. These soils are in the Grantsdale, Hawk-sell, Keeldar, Manhattan, and Ouray series and the Ouray series, thick surface variant. The soils have a surface layer of sandy loam, gravelly sandy loam, or gravelly loam and a subsoil or underlying layer of gravelly sandy loam to sandy clay loam. Slopes range from 1 to 9 percent. The average annual precipitation is 11 to 15 inches, and the frost-free season is 60 to 110 days.

Permeability in these soils is moderate to rapid. Runoff is slow to rapid, and the hazard of erosion is slight to moderate. Gullies form on the steeper slopes in places. Available water capacity is low to moderate. Effective rooting depth is 60 inches or more.

These soils are used for growing hay, permanent pasture, and small grains. Alfalfa, oats, and barley are the main crops. Adapted grasses for pasture and hay are smooth brome, orchardgrass, timothy, and fescue. Adapted legumes are alfalfa, alsike clover, Ladino clover, and red clover.

Suitable methods of irrigation are the contour-ditch and sprinkler methods where slopes are more than 3 percent. Borders, furrows, and corrugations can be used where slopes are less than 3 percent. Close-spaced ditches allow the use of small irrigation heads and re-use of the water. The low available water capacity of these soils makes frequent, light irrigations necessary. The depth of the soils allows limited land leveling or smoothing, which increases irrigation efficiency and reduces the hazard of erosion. Grass crops respond to nitrogen fertilizer. Phosphate fertilizer is needed for a good growth of legume crops.

#### CAPABILITY UNIT IVw-1, IRRIGATED

This capability unit consists of deep, moderately deep, and shallow soils that overlie sand, gravel, and cobbles at a depth of 10 to 60 inches. These soils are in the Adilis, Antero, Chaffee, Collegiate, Gas Creek, and Sawatch series. They are mostly somewhat poorly drained or poorly drained. The soils have a surface layer of loam, sandy loam, and gravelly sandy loam and underlying layers of fine sandy loam, sandy loam, and gravelly or cobbly sandy loam. There is a thin organic mat on the surface in most places. Slopes range from 1 to 5 percent. The average annual precipitation is 11 to 15 inches, and the frost-free season is 75 to 110 days.

Permeability in these soils is moderate to very rapid. Runoff is slow, and the hazard of erosion is slight. Available water capacity is low to moderate. Effective rooting depth is 60 inches or more. A seasonal high water table is at a depth of 0 to 3 feet.

These soils are used for growing hay and permanent pasture. Water-tolerant grasses, sedges, and rushes are common native plants. The water-tolerant plants result from the seasonal high water table. The soils are saturated for most of the growing season, and only during limited periods are they dry enough that they can be worked for the purpose of renovating the plant cover.

Contour ditching is the most practical irrigation method. Ditches should be spaced close enough to permit "on-off" irrigation. Shallow surface drains are needed in many fields to drain low spots or areas where water ponds. Land leveling is not practical, because of the seasonal high water table. Permitting the soil to dry and warm up between irrigations encourages growth of more productive plants. Overseeding with red clover or alsike clover and timothy, reed canarygrass, fescue, or creeping meadow foxtail can be done wherever the soils are renovated and an adequate system of water management has been developed. Fertilizers, especially nitrogen, increase plant growth where proper water management is used.

#### CAPABILITY UNIT IVe-1, IRRIGATED

St. Elmo gravelly sandy loam, 1 to 3 percent slopes, is the only soil in this capability unit. It is a shallow or moderately deep, well-drained soil over cobbly and

gravelly material, which is at a depth of 20 to 36 inches. It has a surface layer of gravelly sandy loam and a subsoil of gravelly and cobbly loamy sand. The average annual precipitation is 11 to 15 inches, and the frost-free season is 60 to 100 days.

Permeability in this soil is rapid. Runoff is slow, and the hazard of erosion is slight. The available water capacity is low. The effective rooting depth is 60 inches or more.

This soil is used for hay, permanent pasture, and small grain. Grass hay is the main use. Adapted grasses for pasture and hay are smooth brome, orchardgrass, timothy, and fescue. Adapted legumes are alsike clover, Ladino clover, and red clover.

The most suitable methods of irrigation are the corrugation, contour-ditch, and sprinkler methods. The low available water capacity makes frequent and light irrigations necessary. Land leveling is not practical, because of the shallow depth to cobbles and gravel.

Grass crops respond to nitrogen fertilizer. Phosphate fertilizer is needed for a good growth of legume crops.

#### CAPABILITY UNIT Vw-1, IRRIGATED

This capability unit consists of shallow to moderately deep, poorly drained soils that overlie cobbles, gravel, and sand at a depth of 10 to 40 inches. These soils are in the Newfork and Rosane series. They have a surface layer of loam, sandy loam, or gravelly sandy loam and a subsoil of sandy loam or very gravelly sandy loam. Slopes range from 1 to 5 percent. The average annual precipitation is 12 to 25 inches, and the frost-free season is 15 to 80 days.

Permeability in these soils is moderately rapid and rapid. Runoff is slow, and the hazard of erosion is slight. Available water capacity is low. Effective rooting depth is 60 inches or more. A seasonal high water table is at a depth of 0 to 1 foot. The soils are cold.

These soils are used for growing hay and permanent pasture. Because of the high water table, water-tolerant grasses, sedges, and rushes are common plants. These soils are saturated during the growing season. The soils are both too wet and too cold for growing alfalfa.

Flooding between contour ditches is the most practical method of irrigation. Shallow drain ditches are needed to remove excess water from low areas. Shallowness, the thick organic mat on the surface, and the high water table make renovation of these soils difficult. Good irrigation management is needed for the soils to dry and warm up in order to slowly reduce the peat layer and allow the more productive grasses to increase. Nitrogen fertilizer increases plant growth if water management is good.

#### CAPABILITY UNIT VIc-1, IRRIGATED

This capability unit consists of very shallow to moderately deep soils that overlie cobbles, gravel, and sandy material at a depth of 8 to 60 inches or are coarse textured in all parts. These soils are in the Costilla, Coto-paxi, Dominson, Pando, Poncha, and St. Elmo series. They are well-drained and somewhat excessively drained soils that have a profile of sandy loam, gravelly sandy loam, loamy sand, or sand. Slopes range from 3 to 9 percent. The average annual precipitation is 10 to 20 inches, and the frost-free season is 50 to 110 days.

Permeability in these soils is moderately rapid, very rapid, and rapid. Runoff is moderate to slow, and the hazard of erosion is moderate or high. Gullies form on steeper slopes in places. Available water capacity is low. Effective rooting depth is 60 inches or more.

These soils are used for growing hay, permanent pasture, and small grain. Alfalfa is the main crop on most of the acreage, and oats and barley are grown as a companion crop when seeding alfalfa or grass. Alfalfa is not well suited to the Poncha and Pando soils, because of the shorter growing season. Adapted grasses for pasture and hay are smooth brome, intermediate wheatgrass, Russian wildrye, orchardgrass, and timothy. Adapted legumes are red clover, alsike clover, and alfalfa.

The most practical methods of irrigation are the contour-ditch and sprinkler methods. If surface irrigation is used, contour ditches should be closely spaced to prevent the loss of water through deep percolation, to prevent water accumulation, and to help control erosion. Light, frequent irrigations are necessary to prevent loss of water and to overcome the low available water capacity of the soils. Land leveling is not feasible, because of the depth to gravel, cobbles, and sand material. Grass crops respond to nitrogen fertilizer. Phosphate fertilizer is needed for maximum growth of legume crops.

#### Predicted Yields

In this subsection are predictions of yields for the soils that are suitable for irrigation. The estimates are based on yield records of agricultural programs and on individual farm records.

Table 2 gives the predicted average acre yields of principal irrigated crops grown in the Chaffee-Lake Area under a high level of management. These predictions are averages over a period of years, not yields for any particular year.

To keep management of irrigated soils at a high level and to obtain the yields in table 2, a farmer or rancher must:

1. Have an adequate supply of irrigation water.
2. Have an efficient irrigation system.
3. Use conservation practices for minimizing soil erosion and water losses, such as land leveling or smoothing, controlled length of irrigation run, contour ditches, and similar practices.
4. Maintain soil fertility by utilizing available manure and by applying commercial fertilizer as indicated by soil tests.
5. Seed climatically adapted crops and use a systematic cropping system.
6. Control insects and plant diseases consistently.

Under irrigation, the soils in each capability unit are suitable for similar uses and require similar management, but crop yields may differ from one soil to the next in the same unit and differ slightly from place to place on the same soil.

#### Management of Nonirrigated Soils

Because the growing season is short and annual precipitation is low, no soils in the survey area are used



TABLE 2.—*Predicted average acre yields of principal crops grown on irrigated soils*

[Absence of an entry in a column indicates that the crop is not suited to the soil or is not commonly grown on it]

Soil	Alfalfa (hay)	Native grass meadow (hay)	Small grain (oats)
	Tons	Tons	Bu
Adilis loam, 1 to 5 percent slopes.....		3.0	
Antero sandy loam, 1 to 3 percent slopes.....		3.0	
Blanyon clay loam, 1 to 3 percent slopes.....	3.0		60
Chaffee loam, 1 to 3 percent slopes.....		3.0	
Collegiate loam, 1 to 3 percent slopes.....		4.0	
Costilla gravelly sandy loam, 3 to 9 percent slopes.....	3.0		
Cotopaxi loamy sand, 3 to 9 percent slopes.....	3.0		45
Dominson gravelly sandy loam, 1 to 9 percent slopes.....	2.5		
Gas Creek gravelly sandy loam, 1 to 3 percent slopes.....		3.0	
Grantsdale fine sandy loam, 3 to 9 percent slopes.....	4.0		75
Hawksell sandy loam, 5 to 9 percent slopes.....	3.0		
Keeldar gravelly sandy loam, 1 to 5 percent slopes.....	3.0		55
Manhattan sandy loam, 1 to 3 percent slopes.....	3.0		55
Manhattan sandy loam, 3 to 9 percent slopes.....	3.0		50
Newfork gravelly sandy loam, 1 to 3 percent slopes.....		2.5	
Ouray sandy loam, 1 to 5 percent slopes.....	4.0		70
Ouray gravelly loam, thick surface variant, 1 to 3 percent slopes.....	4.0		75
Rosane loam, 1 to 5 percent slopes.....		2.0	
St. Elmo gravelly sandy loam, 1 to 3 percent slopes.....	2.5		
St. Elmo gravelly sandy loam, 3 to 9 percent slopes.....	2.0		
Sawatch sandy loam, 1 to 5 percent slopes.....		2.5	
Shrine clay loam, 3 to 9 percent slopes.....	4.0		55

for nonirrigated crops. Also, there are no soils in capability classes I through V. The management practices discussed in this section by nonirrigated capability units are defined in the sections "Range" and "Woodland."

Following are descriptions of the nonirrigated capability units in the survey area.

#### CAPABILITY UNIT VI-2, NONIRRIGATED

This capability unit consists of deep, well-drained soils in the Blanyon and Shrine series. These soils have a surface layer of clay loam and a subsoil or underlying layer of clay loam and silty clay loam. Slopes range from 1 to 9 percent. The average annual precipitation is 10 to 15 inches, and the frost-free season is 75 to 110 days.

Permeability in these soils is slow and moderately slow. Runoff is slow to rapid, and the hazard of erosion is moderate and high. Available water capacity is high. Effective rooting depth is 60 inches or more.

These soils are used for pasture. Adapted pasture plants are crested wheatgrass, pubescent wheatgrass, Russian wildrye, and yellowblossom sweetclover.

To establish a plant cover, nearly all areas of these soils can be seeded by using normal equipment. All important range management practices are essential in maintaining or improving the plant cover. Among these practices are deferred and rotation grazing and proper range use.

#### CAPABILITY UNIT VI-3, NONIRRIGATED

In this capability unit are soils that are moderately deep to very shallow over gravel and cobbles. Also in the unit are soils that are deep and well drained. The

soils in this unit are in the Cabin, Costilla, Cotopaxi, Dominson, Grantsdale, Hawksell, Keeldar, Manhattan, Ouray, Pierian, Poncha, and St. Elmo series and the Ouray series, thick surface variant. The surface layer is sandy loam, gravelly sandy loam, or loamy sand, and the subsoil or underlying layer is loamy sand, gravelly sandy loam, or sandy clay loam. The soils are underlain by sand or by gravel and cobbles, or both, at a depth ranging from 8 to 60 inches. Slopes are 1 to 25 percent.

Generally, the average annual precipitation is 10 to 16 inches, and the frost-free season is 60 to 110 days. The Pierian and Poncha soils, however, are at a higher elevation, where the average annual precipitation is 16 to 25 inches, and the frost-free season is 25 to 60 days. Because the Pierian and Poncha soils are in areas of higher precipitation, they are slightly more productive than the other soils.

Permeability in the soils of this unit is moderate to very rapid. Runoff is slow to rapid, and the hazard of erosion is slight to severe. Available water capacity is low to moderate. Effective rooting depth is 60 inches or more.

These soils are used for range and pasture. Seedings do best if native grasses are used. Indian ricegrass, western wheatgrass, crested wheatgrass, and needle-and-thread are adapted grasses. Yellowblossom sweetclover is an adapted legume.

To establish a plant cover, nearly all areas of these soils can be seeded by using ordinary equipment. Normally, the soils hold enough moisture to permit the establishment of new seedings, but such seedings are difficult to establish on the Dominson, Pierian, and St. Elmo soils because the available water capacity is low. Extreme care must be taken on the Costilla and Coto-

paxi soils to control soil blowing. All of the important range management practices are essential in maintaining or improving the plant cover. Among these practices are deferred and rotation grazing and proper range use.

#### CAPABILITY UNIT VIc-4, NONIRRIGATED

This capability unit consists of deep, well-drained soils in the Granile, Leadville, Troutville, and Pando series. These soils have a surface layer of gravelly sandy loam to sandy loam and a subsoil of extremely stony or very gravelly sandy loam to clay loam. Slopes range from 3 to 35 percent. The average annual precipitation is 12 to 25 inches, and the frost-free season is 10 to 75 days.

Permeability in these soils is moderately slow to moderately rapid. Runoff is medium to rapid, and the hazard of erosion is moderate. Available water capacity is low or moderate. Effective rooting depth is 60 inches or more.

These soils are used for woodland and recreation. The trees are mostly lodgepole pine, Engelmann spruce, and subalpine fir, but there is also some ponderosa pine. Because the growth rate of these soils is slow, recommended woodland management is limited to thinning, pruning, fire protection, and insect control.

#### CAPABILITY UNIT VIc-5, NONIRRIGATED

Tomichi sandy loam, 5 to 25 percent slopes, is the only soil in this capability unit. This is a deep, somewhat excessively drained soil. It has a surface layer of sandy loam that is over an underlying layer of gravelly sand at a depth of about 13 inches. The average annual precipitation is 16 to 22 inches, and the frost-free season is 10 to 75 days.

Permeability in this soil is rapid. Runoff is slow, and the hazard of water erosion is moderate. Soil blowing is a moderate hazard. Available water capacity is low. Effective rooting depth is 60 inches or more.

This soil is used for range, wildlife habitat, and recreation. The plant cover generally is dominated by Thurber's fescue and silver sagebrush.

To establish a plant cover, most areas of this soil can be seeded by using normal equipment. When the surface is bare, however, care must be taken to control soil blowing. The grazing period is limited to about 3 months because of altitude, which is generally above 10,000 feet. All of the important range management practices are essential to maintain or improve the plant cover.

#### CAPABILITY UNIT VIIc-1, NONIRRIGATED

This capability unit consists of deep, well-drained to excessively drained soils and miscellaneous land types. These are in the Dominson, Pierian, St. Elmo, Tigiwon, and Turret series; Rough broken land; and Rough broken land, cold. The soils have a surface layer of gravelly sandy loam to cobbly sandy loam and a subsoil of gravelly or cobbly sandy clay loam or underlying layers of gravelly loamy sand or gravel, cobbles, and sand. They overlie cobbles, sand, and gravel or very cobbly loamy sand at a depth of 8 to 36 inches. Slopes range from 3 to 45 percent. The average annual precipi-

tation is 11 to 20 inches, and the frost-free season is 25 to 100 days.

Permeability in these soils is very rapid to moderate. Runoff is rapid to medium, and the hazard of erosion is moderate to high. Available water capacity is low. Effective rooting depth is 60 inches or more.

These soils are used for livestock grazing, wildlife habitat, and recreation. Because of steep slopes or a cobbly surface layer or both, the soils generally cannot be seeded by using normal equipment. Some of the areas have an overstory of ponderosa pine, pinyon pine, and juniper that are of limited commercial value. All of the important range management practices are essential to maintain or improve the plant cover, including deferred and rotation grazing and proper range use. The tree cover should be protected from fire because it aids in the control of erosion.

#### CAPABILITY UNIT VIIc-2, NONIRRIGATED

Bross gravelly sandy loam, 9 to 45 percent slopes, is the only soil in this capability unit. It is a deep, well-drained soil that has a surface layer of gravelly sandy loam and a subsoil of cobbly fine sandy loam. The average annual precipitation is 20 to 30 inches, and the frost-free season is less than 10 days.

Permeability in this soil is moderately rapid. Runoff is rapid, and the hazard of erosion is moderate. Available water capacity is low. Effective rooting depth is 60 inches or more.

This soil is used for livestock grazing, wildlife habitat, and recreation. Because of the steepness of slope, normal equipment can be used only to a limited extent for seeding. Seeding is a questionable practice because of the short frost-free period. This soil can be used for grazing only for a short time in summer because the growing season is short and plant growth is limited. Deferred and rotation grazing and proper range use are essential to maintain or improve the plant cover.

#### CAPABILITY UNIT VIIw-1, NONIRRIGATED

Only Wet alluvial land is in this capability unit. This mapping unit consists of deep, nearly level to gently sloping, mixed, stratified alluvial material along the first bottoms of major streams. It is subject to overflow and has a high water table.

The land can be used for livestock grazing, wildlife habitat, and recreation. Areas that can be protected from overflow damage are potentially suitable as cabin sites.

#### CAPABILITY UNIT VIIs-1, NONIRRIGATED

San Isabel stony sandy loam, 1 to 5 percent slopes, is the only soil in this capability unit. This is a deep, somewhat excessively drained soil. It has a surface layer and subsoil of stony sandy loam and gravelly sandy loam that overlie gravel, cobbles, and boulders at a depth of about 19 inches. The average annual precipitation is 11 to 16 inches, and the frost-free season is 75 to 100 days.

Permeability in this soil is rapid. Runoff is slow, and the hazard of erosion is slight.

This soil is used for livestock grazing and for winter food for wildlife. Because of the stony surface layer, the soil is not workable with ordinary equipment. Al-

though the annual precipitation is relatively low, moisture accumulates in the soil between the boulders and plant production is moderately high. All of the important range management practices are essential to maintain or improve the plant cover, including deferred and rotation grazing and proper range use. Ponderosa pine, pinyon pine, and juniper grow on some areas but are of limited commercial value. The tree cover helps to control erosion and should be protected from fire.

#### CAPABILITY UNIT VIIIc-1, NONIRRIGATED

Only Badland is in this capability unit. This mapping unit consists of severely eroded material that varies in texture. Slopes are dominantly 10 percent to more than 50 percent. The slopes are complex, and the topography is rough. The plant cover is sparse and is chiefly stunted trees of pinyon pine and juniper. Badland is suitable for some recreational purposes, wildlife habitat, and watershed.

#### CAPABILITY UNIT VIIIb-1, NONIRRIGATED

This capability unit consists of outcropping bedrock, very shallow and shallow soil material over bedrock, stony and cobbly soil material, and manmade areas connected with mining. In the unit are Gravelly alluvial land; Mine pits and dumps; Placer diggings and tailings; Rock land, 15 to 60 percent slopes; Rock land-Gravelly land complex, 3 to 35 percent slopes; Rock land-Stecum complex, 15 to 60 percent slopes; Rock outcrop; Rock slides; and Slickens.

Areas of this unit are suited to watershed, wildlife habitat, and some recreational purposes. Scrubby ponderosa pine, pinyon pine, and juniper grow in some areas of Rock land and Rock outcrop. These trees are of little or no commercial value, but they should be protected from fire to help control erosion.

#### CAPABILITY UNIT VIIIw-1, NONIRRIGATED

In this capability unit are Marsh and Peat. These consist of wet, very poorly drained, shallow to deep peat and muck that overlie sand, gravel, and cobbles. They are on first bottoms of streams and in some swales on terraces. They have a high water table and are subject to overflow.

Marsh and Peat produce little forage except sedges, rushes, cattails, and other water-tolerant plants. Wildlife use the areas for winter feed and protection. Commercial peat moss is being harvested in some areas, but such harvesting requires special equipment.

## Range<sup>2</sup>

Range has always been an important part of the economy in the Chaffee-Lake Area. Even during the early mining period, range was important as a source of grazing for the horses and mules. The range in the survey area is used mostly for the grazing of cattle, although it is equally well suited to sheep. Sheep are better able to graze the alpine range, the high altitude of which is unhealthy for cattle. The range of the sur-

vey area is mainly on gently sloping to steep terraces on old glacial outwash material at the base of the high mountains. In addition, however, there are higher mountain valleys and steep, rough alpine range within the survey area.

The kinds of range are rather closely associated with climate and effective moisture. Below an elevation of about 8,200 feet, the principal range sites are Dry Mountain Outwash, Sandy Bench, and Boulder Flats.

Mountain Outwash is the principal range site above an elevation of about 8,200 feet. Above approximately 10,000 feet, and up to near the timberline, Subalpine Loam is the dominant range site. Above the timberline, Alpine Slopes are dominant.

Within transitions between climatic zones, it is difficult to correlate kinds of range to climate because of gradual changes in soil characteristics. Commonly, a range site in one climatic zone is also in another climatic zone because of microrelief, aspect, and other associated climatic factors.

Cattle and sheep are grazed in the survey area. Most of the operating units are cow-calf ranches, but there are a few sheep ranches. Some ranchers depend on the public domain, both inside and outside the survey area, for summer range.

Nearly all of the ranches have irrigated hayland or irrigated pasture to provide winter feed.

### *Range management practices*

Proper grazing use is the most important practice in managing the range. The value of this practice is borne out by the experience of better livestock operators. Food for plant growth is manufactured in the plant's leaves, and therefore if range plants are to produce abundant forage, no more than about half of the growth should be removed by grazing. This practice results in improved range condition or, at the least, maintenance of the stand where condition is already good to excellent.

Healthy range plants have vigorous root systems that go deep for moisture, but plants weakened by overgrazing cannot produce such deep root systems. Forage left on the ground serves as mulch that increases the intake of moisture into the soil.

On range in the mountains, it is practical to graze livestock only late in spring and in summer and fall. Hay for wintering livestock is produced on the irrigated soils. Sheep generally are wintered outside the survey area.

The first few inches of leaf growth on grass depends on food stored in the roots. After this growth is attained, the leaves can manufacture food for further growth of leaves and roots. Grazing too early in spring at the time of initial plant growth probably is the most damaging range practice. Postponing grazing until forage plants have sufficient growth generally is incorporated into a good system of grazing. During the period of initial growth, range forage generally is more palatable and nutritious than during any other period. The rancher must provide additional hay and other supplements during this critical time. Selected areas of range, seeded to such cool-season grasses as crested

<sup>2</sup> FORREST C. MAHAFFEY and THOMAS K. EAMAN, range conservationists, Soil Conservation Service, assisted in preparing this section.

wheatgrass, can be used as dryland pasture during this period.

Another important practice for improvement of range is that of deferred and rotation grazing. This system provides for complete rest from the beginning of growth in the spring through the seed-production stage. This rest period is ideal every third or fourth year for increasing the stand of the more desirable species.

The foregoing management practices are applicable to all range sites in the survey area.

Brush control by mechanical means or by aerial application of herbicides is important in reducing the population of undesirable plants. A year of complete rest generally is required following brush control.

Range seeding is applicable where the natural plant cover has become so depleted that rejuvenation by management alone is impractical. Seed can be introduced on any of the range sites by broadcasting, but drilling seed in a prepared seedbed is the better method, except in areas where pinyon is chained. In these areas, seed is broadcast from an airplane ahead of the chaining. Terrain and stoniness are factors that limit the use of seed-drilling equipment to selected areas.

Natural springs, streams, and irrigation ditches furnish livestock water. Ranch operations generally can be improved by the installation of properly located watering facilities. This usually consists of constructing stock ponds and developing existing natural springs. Watering facilities generally should be so located that livestock have to travel no more than one-half mile. This distance is sometimes much less because of such factors as steep slopes and natural barriers.

Livestock can be encouraged to use all parts of the range by proper location of salt licks. This practice, and adequate fencing, water, and herding, comprise the major requirements for proper utilization of range resources.

#### ***Range sites and range condition***

A range site is a distinctive kind of range that has a certain potential for producing range plants. Each range site has its own combination of environmental conditions, and these produce its natural plant community. So long as the environment remains unchanged, the range site retains its ability to produce this potential plant community unless materially altered by physical deterioration.

Range that is used primarily for grazing livestock and wildlife is being diverted to other uses. Highways, airports, and other public facilities are being developed in areas that formerly were range. The demand for recreation areas and facilities continues to increase. Land-use planners have an increasing need for information relating to basic natural resources. Range site descriptions, as found in this section, provide information on (a) ecological relationships to persons who are interested in the flora of the survey area, (b) the adaptability of plant species for specific geographic locations because this information is useful in right-of-way restoration and natural landscaping, (c) outdoor ecological laboratory, and (d) land suitability for urban development and associated structures.

The inherent productive capacity of a range site, like that of other farmland, depends on the combined effect or interaction of the soil and climate peculiar to it.

The range site is the basic unit of range on which management and treatment are determined.

The user of range needs to know the capabilities of different range sites in terms of the kind and quantity of range plants they can be expected to be produced. He must also be able to appraise the present condition of these plants in relation to their potential.

The condition of the range is determined by comparing the present vegetation with the vegetation in the potential plant community for the range site or sites. The purpose of determining condition is to provide a measure of any deterioration that has taken place and thereby provide a basis for predicting the degree of improvement that is possible.

Condition is an ecological rating. When range is described as being in "poor condition" or "fair condition," the description is an ecological rating at a given time for that particular range site. The condition is the present kind and amount of plants in the vegetative composition compared to the potential production for the site.

Four classes of range condition are recognized, excellent, good, fair, and poor. On range in excellent condition, 76 to 100 percent is about the same as the potential plant community for the site. Range in good condition has a plant cover in which 51 to 75 percent of the plants are nearly the same as the potential community for the site. On range in fair condition, 26 to 50 percent of the plant cover is about the same as the potential for the site. If range is in poor condition, 0 to 25 percent of the vegetation consists of the potential plant community.

Knowledge of the climax plant communities of range sites and the nature of present plant communities in relation to their potential is important in planning and applying conservation on range. Such information is the basis for selecting management objectives, designing a grazing system, managing for wildlife, determining potential for recreation, and rating watershed conditions.

Any management objective on range must provide for a plant cover which will adequately protect or improve the soil and water resources and meet the needs of the operator. This usually involves increasing the stand of desirable plants and restoring the plant community to near climax conditions. In places, however, a plant cover somewhat below climax condition will better fit specific grazing needs, provide better wildlife habitat, or furnish other benefits and still protect the soil and water resources.

Range sites within the survey area are described in the following pages. Climax plants are listed for each site and so are those species that are likely to increase or to invade an area under continuous close grazing or overgrazing. In addition, an estimate of the potential annual production of air-dry vegetation is indicated for each site.

**BOULDER FLATS RANGE SITE**

This range site consists of nearly level to gently sloping soils on terraces, generally near the Arkansas River. These soils are stony sandy loams that are shallow over gravel and cobbles. The subsoil is moderately coarse textured. Large round boulders occur at random on the soil surface. Many of these are nearly buried. The large stones tend to concentrate moisture into the soil between them, and this increases the effective moisture for plant growth.

The potential plant community is mostly grasses, though forbs and woody plants are present in small amounts. Pinyon pine and ponderosa pine in scattered stands appear to be part of the native vegetation.

The approximate composition of the potential plant community is 40 percent Indian ricegrass, 15 percent needle-and-thread, 5 percent western wheatgrass, 5 percent junegrass, 5 percent native bluegrasses, 5 percent mountain muhly, 5 percent Arizona fescue, 3 percent sand dropseed, 2 percent three-awn, 5 percent squirrel-tail, 3 percent slimstem muhly, 2 percent wax currant, 3 percent fringed sagebrush, and 2 percent pinyon and ponderosa pines.

The total annual air-dry yield varies from 1,200 pounds per acre in years of favorable growing conditions to 800 pounds in years of poor growing conditions. Approximately 85 percent of this production is from plants that furnish forage for sheep and cattle.

Continuous heavy grazing causes a decrease in Indian ricegrass, bunch bluegrasses, mountain muhly, and Arizona fescue. This decrease is accompanied by an increase in sand dropseed, three-awn, slimstem muhly, fringed sagebrush, and other plants less frequently selected by grazing animals. If overgrazing is prolonged, sleepy grass, pingue, and low-producing annuals invade the site and total yields are seriously reduced.

**SUBALPINE LOAM RANGE SITE**

This site consists of open park areas that are associated with lodgepole pine, Engelmann spruce, and subalpine fir. It is on gently sloping to moderately steep terrain. The soils are sandy loam. Moisture is available for plant growth most of the time during the growing period, both from melted snow water in the soil and from frequent summer rains. The average annual precipitation is 16 to 22 inches.

The potential plant community is grass. The approximate composition of the potential plant community is 25 percent Thurber's fescue, 5 percent Arizona fescue, 5 percent native bluegrasses, 5 percent Parry oatgrass, 5 percent nodding brome, 5 percent bearded wheatgrass, 5 percent American vetch, 5 percent needlegrasses, 5 percent western wheatgrass, 5 percent sedges, 15 percent perennial forbs, 5 percent big sagebrush, 5 percent silver sagebrush, 3 percent snowberry, and 2 percent shrubby cinquefoil.

The total annual air-dry yield varies from 4,000 pounds per acre in years of favorable growing conditions to 2,000 pounds in years of poor growing conditions. Approximately 90 percent of this production is from plants that furnish forage for livestock.

Continuous heavy grazing causes a decrease in nodding brome, bearded wheatgrass, American vetch, bunch bluegrass, Parry oatgrass, and Thurber's fescue. As these plants decrease, needlegrasses, western wheatgrass, sedges, yarrow, pussytoes, sagebrush, and other plants less selected by grazing animals increase strongly. Prolonged overgrazing or continuous heavy grazing results in a plant cover that is dominantly rabbitbrush, mules-ears, knotweed, and other plants of low forage value.

**SANDY BENCH RANGE SITE**

This site consists of nearly level to sloping soils on valley slopes, fans, benches, and terraces. These soils are deep to moderately deep over sand, gravel, and cobbles. They are loamy sands, sands, sandy loams, and gravelly sandy loams. Soil moisture generally is available for plant growth except during the driest season.

The potential plant community is mostly a mixture of grasses, although forbs and woody plants are present in small amounts. The approximate composition of the potential plant community is 35 percent Indian ricegrass, 15 percent needle-and-thread, 15 percent sand dropseed, 5 percent blue grama, 5 percent squirreltail, 3 percent slimstem muhly, 2 percent red three-awn, 5 percent four-wing saltbush, 3 percent winterfat, 3 percent snakeweed, 2 percent low rabbitbrush, 2 percent buckwheats, and 5 percent perennial forbs.

The total annual air-dry yield varies from 1,100 pounds per acre in years of favorable growing conditions to 800 pounds in years of poor growing conditions. Approximately 80 percent of this production is from plants that furnish forage for sheep and cattle.

Continuous heavy grazing causes a decrease in Indian ricegrass, needle-and-thread, four-wing saltbush, and other plants most selected by grazing animals. As these plants decrease, blue grama, sand dropseed, three-awn, rabbitbrush, snakeweed, and wormwood increase. If overgrazing is prolonged, sleepy grass, ring muhly, tall rabbitbrush, pingue, and similar plants invade the site and total yields are greatly reduced.

**DRY MOUNTAIN OUTWASH RANGE SITE**

This site consists of nearly level to steep soils on terraces and benches. These soils generally are below an elevation of 8,200 feet on old glacial outwash materials. The soils are moderately coarse textured. Water is taken in rapidly, much of which percolates to depths beyond the rooting depth of most range plants. Moisture available for plant growth is less than that of the Mountain Outwash range site.

The potential plant community is mostly grass, but forbs and shrubs are present in small amounts. The approximate composition of the potential plant community is 10 percent bunch bluegrasses, 15 percent junegrass, 10 percent pine needlegrass (also called pinewoods needlegrass), 10 percent Indian ricegrass, 10 percent needle-and-thread, 10 percent blue grama, 5 percent sand dropseed, 5 percent slimstem muhly, 15 percent squirreltail, 5 percent fringed sagebrush, and 5 percent wax current and buckwheat.

The total annual air-dry yield varies from 600 pounds per acre in years of favorable growing con-



ditions to 400 pounds in years of unfavorable growing conditions. Approximately three-fourths of this production is from plants that furnish forage for livestock.

Continuous heavy grazing causes a decrease in junegrass, bunch bluegrasses, Indian ricegrass, and needle-and-thread. As these plants decrease, blue grama, sand dropseed, slimstem muhly, and fringed sagebrush increase. If overgrazing is prolonged, snakeweed, ring muhly, pinyon pine, sleepy grass, and annual weeds invade the site and total yields are greatly reduced.

#### MOUNTAIN OUTWASH RANGE SITE

This site consists of nearly level to steep soils on old glacial outwash materials. It is generally on terraces and fans above an elevation of 8,200 feet. The soils are moderately coarse textured. Water is taken in moderately rapidly to very rapidly, but, because internal drainage is very rapid, it is not readily available for plant growth.

The potential plant community is almost entirely grasses. The approximate composition of the potential plant community is 25 percent Arizona fescue, 10 percent mountain muhly, 5 percent needlegrasses, 5 percent wheatgrasses, 5 percent bunch bluegrasses, 5 percent junegrass, 5 percent Indian ricegrass, 5 percent blue grama, 5 percent slimstem muhly, 10 percent squirreltail, 10 percent sedges, 5 percent fringed sagebrush, and 5 percent cinquefoils.

The total annual air-dry yield varies from 1,000 pounds per acre in years of favorable growing conditions to 600 pounds per acre in years of poor growing conditions. Approximately 90 percent of this production is from plants that furnish forage for sheep and cattle.

Continuous heavy grazing causes a decrease in Arizona fescue, mountain muhly, wheatgrasses, and bunch bluegrasses. As these plants decrease, fringed sagebrush, slimstem muhly, and blue grama increase. If overgrazing is prolonged, pingue, sleepy grass, mat muhly, pricklypear, snakeweed, and annuals invade the site and total yields are reduced.

#### ALPINE SLOPES RANGE SITE

This range site consists of sloping to steep soils above timberline. These soils are well drained, moderately coarse textured, and cobbly. Availability of moisture for plant growth depends largely on frequent summer storms during the short growing period.

The potential plant community is mostly grasses, but many kinds of forbs and woody plants are in the plant cover. The approximate composition of the potential plant community is 5 percent alpine bluegrasses, 10 percent tufted hairgrass, 40 percent kobresia, 10 percent wheatgrasses, 10 percent alpine clovers, and 25 percent perennial forbs.

The total annual air-dry yield varies from 1,200 pounds per acre in years of favorable growing conditions to 500 pounds in years of poor growing conditions. Approximately 90 percent of this production is from plants that furnish forage for sheep and cattle.

Continuous heavy grazing causes a decrease in tufted hairgrass, clovers, wheatgrasses, and bluegrasses. As these plants decrease, kobresia and perennial forbs of

a mat-forming type increase. New plants invade this site as a result of prolonged overgrazing. Instead of a change in plant cover by invading plants, the result is generally a thin stand accompanied by much exposed bare ground and low plant yields.

### Woodland and Windbreaks<sup>3</sup>

The native woodland in the Chaffee-Lake Area is confined to the edges of the survey area and adjacent to the national forest boundaries. Here, the pattern of tree growth shows that these wooded areas form the transitional part of the forest rather than the more productive part of it.

In addition to lumber and other forest products, properly managed woodland produces (1) livestock grazing, (2) water for livestock and domestic use, (3) protection for the water supply, (4) such recreation uses as camping, picnicking, and nature areas, (5) sites for summer homes, and (6) wildlife habitat.

#### Forest-cover types

Forest-cover types are means by which forests can be classified. A forest-cover type is a stand of trees whose make-up and development result from a given combination of soil, climate, aspect, and elevation. Because of these factors, each stand is different. The forest cover is identified by the dominant species that make up 50 percent or more of the stand.

The woodland in the Chaffee-Lake survey area is divided into three forest types. These are pinyon pine-juniper, ponderosa pine, and lodgepole pine.

*Pinyon pine-juniper type* of forest cover is at elevations between 7,000 and 8,000 feet where coniferous trees grow. It is an association of species of pinyon pine and juniper and has a grass understory. Juniper is dominant in the driest and lowest areas, but pinyon pine commonly is more plentiful at the upper elevations. Fenceposts and firewood are the principal uses of these trees. Trees generally grow on steep slopes or on thin rocky soils. The pinyon pine-juniper type is commonly in the Rock land-Rock outcrop association, the Dominson-San Isabel association, and in the Rough broken land-Badland association of soils. Livestock graze the grass understory.

*Ponderosa pine type* of forest cover is limited in acreage and is at elevations between 7,800 and 8,500 feet, generally above the pinyon pine and juniper trees. Trees grow better on north-facing and east-facing exposures. Ponderosa pine grows more rapidly and larger on deeper soils that contain more moisture than on thin or extremely rocky soils. Ponderosa pine is used for lumber, railroad ties, poles, fenceposts, and mine props. In places the stand of trees is dense, but many areas, especially of older trees, have an open canopy. The understory of grass can be moderately grazed without damage to the trees. On steep northern exposures a few Douglas-firs are mixed with the pine. The ponderosa pine type is most commonly in the Rock land-Rock outcrop association and on soils of the Dominson-San Isabel association.

<sup>3</sup> W. S. SWENSON, woodland conservationist, Soil Conservation Service, helped prepare this section.

*Lodgepole pine* type of forest cover is at elevations between 8,200 and 10,000 feet, generally above the ponderosa pine type. Lodgepole pine type is characterized by dense stands of small, straight trees. Growth is commonly stagnated because the trees are closely spaced. Trees 100 years old may be only of fencepost size. Lodgepole pine is a so-called "fire type" because it becomes established after forest fires. Much of the lodgepole pine is the result of man's carelessness with fire during the days of the mining boom when the forests were cut for lumber, railroad ties, and mine props. Lodgepole pine probably will remain dominant in these areas for many years, but in time it likely will be replaced by Engelmann spruce or subalpine fir at the upper elevations. At the lower elevations lodgepole pine has replaced Douglas-fir. In some areas quaking aspen is mixed with lodgepole pine. The understory in areas of quaking aspen provides good grazing for livestock. The lodgepole pine type is largely on the Troutville-Leadville association of soils and provides little grazing for livestock.

#### **Woodland suitability groups**

A woodland suitability group is made up of soils that produce similar kinds of woodland crops, need similar management to produce these crops, and have about the same potential productivity. The soils in the survey area suitable for woodland have been grouped into three woodland suitability groups. The site index, productivity, management, and limitations and hazards are given for soils in woodland suitability groups 1 and 2. Soils in group 3 are of little value as woodland.

*Site index* is a measurement of the relative productivity of a woodland area. It is based on the average height of dominant and codominant trees at a certain age, generally 100 years. For example, a site on which the trees are 100 years old and averaged 50 feet in height would have a site index of 50.

*Trafficability* refers to the ability of soils to carry machine and truck traffic without serious hazard of erosion and damage to the land.

#### **WOODLAND SUITABILITY GROUP 1**

This group consists of soils that are mostly in Lake County under the Lodgepole pine type of forest cover. These soils are moderately deep to deep, moderately coarse textured, and well drained. They formed in till and outwash gravel and cobbles and are gently sloping to steep.

On the soils of this group, the site index ranges from 40 to 55 for lodgepole pine and from 50 to 60 for Engelmann spruce.

If these soils are used for growing timber in unmanaged stands, the average annual growth is less than 50 board feet per acre per year for lodgepole pine. Engelmann spruce, in unmanaged stands, produces 50 to 100 board feet per acre per year.

Management practices, such as thinning, increase the rate of growth from 50 to 100 percent. Even with the increased rate of growth, however, it is doubtful if intensive management on private land is justified because of the cost involved and the time required.

Management practices that include a harvest of wood products to defray cost is desirable. Conversion from lodgepole pine to Engelmann spruce increases the potential of these soils for the production of wood crops.

Because of the slow rate of growth and difficulty in planting on these soils, planting is limited, especially for wood production. Planting is indicated where control of erosion or watershed protection is desired.

These soils have fair to good trafficability. Slope is the major limitation that affects use of equipment in harvesting wood products. Where slopes are more than 35 percent, equipment limitations are severe and it is not practical to attempt cutting operations involving heavy equipment or road building. Where slopes are less than 35 percent, the major limitation is caused by snow in winter and muddy roads in spring.

The hazard of windthrow is minor.

Brush encroachment on these cutting operations is not a problem. Under good management, trees will reproduce themselves on the soils in this group. Following fire, aspen or lodgepole pine may become established first. Lodgepole pine commonly becomes too thick, and this causes stagnation of growth.

Lodgepole pine in the survey area is little affected by insects. Dwarf mistletoe, a parasitic disease, is severe, especially in stands that are more than 150 to 200 years old.

#### **WOODLAND SUITABILITY GROUP 2**

This group consists of soils in Chaffee County that are under a cover of ponderosa pine, Douglas-fir, or lodgepole pine. These soils are gently sloping to steep, deep and moderately deep, and well drained. They have a moderately coarse textured surface layer and a heavier subsoil over parent material of outwash materials and granite. The soils generally are gravelly.

The site index on these soils ranges from 35 to 45 for lodgepole pine, from 55 to 60 for Douglas-fir, and from 40 to 45 for ponderosa pine.

Unmanaged stands of timber produce about 40 to 100 board feet per acre per year. Because Douglas-fir produces more desirable wood crops, stands of lodgepole pine are better converted to Douglas-fir. Tree harvesting should begin with overmature, deformed, diseased, or insect-infested trees, or trees that interfere with potential crop trees.

In immature stands, cutting should never be on a clear-cut basis but rather as thinnings or improvement cuttings that leave the best trees well spaced for future development and growth.

Planting is limited because the soils are rocky and stony and because there is little opportunity to use planting equipment. Planting for wood production is impractical, but some areas in which natural restocking is unsatisfactory can be planted for protection of the soils and the watershed.

In general, trafficability on these soils is fair to good. The main equipment limitations are snow in the winter and mud in the spring.

Windthrow is not a problem on these soils, and neither is brush encroachment.

Bark beetles are the chief insect enemy on trees in

this group, and dwarf mistletoe is the most damaging disease.

Under good management, ponderosa pine reproduces readily on these soils. Lodgepole pine reproduces readily where large openings are made. Douglas-fir requires some shade before it will reproduce.

#### WOODLAND SUITABILITY GROUP 3

This group consists of shallow to very shallow and cobbly, gravelly, stony outwash soils on which the dominant plant cover is scrubby ponderosa pine, pinon pine, or juniper.

The trees on these soils are of little or no commercial value. Fuelwood, fenceposts, and rough, inferior lumber can be cut in places. These areas generally are better protected by trees than by other kinds of plants, and therefore the trees need to be protected from fire or destructive grazing. The soils of this group are better suited to wildlife habitat, watershed, and recreation. At present, they provide only limited grazing.

#### Windbreaks

Belts of planted trees are desirable around farmsteads or livestock-feeding areas for protection against cold winds and drifting snow. Windbreaks add comfort to the home during windy periods, reduce heating costs, provide shade in the summer, benefit wildlife, and add beauty to the landscape. They can also reduce winter feed requirements for livestock by lessening heat loss caused by the wind.

Farmstead and feedlot windbreaks should consist of three to six rows of trees and shrubs. Shrubs should be planted on the windward side of the windbreak to minimize wind effects through the lower part of the break. Shrubs also help cause snow to drift into the windbreak instead of around buildings or on roads.

Some soils in the survey area are suitable for tree plantings for protective purposes, but other soils have limitations that make tree planting too difficult to be practical. Better adapted soils for growing windbreaks are the irrigated areas of the Blanyon, Dominson, Grantsdale, Hawksell, Keeldar, Manhattan, Ouray, Shrine, and St. Elmo soils. Trees prefer deep, well-drained, neutral to only moderately saline or alkaline soils that have good aeration for the roots.

Tree planting is not feasible where there is considerable fluctuation in the level of the ground water or where the soils are wet to the surface for a large part of the year. The cold temperatures limit the kinds of trees that can be planted. Evergreens are better adapted trees for windbreaks in the survey area, but at the lower elevations, particularly in Chaffee County, some kinds of broadleaf trees can be successfully grown. Windbreaks are not practical to grow on non-irrigated soils in the survey area.

To establish windbreaks successfully, the soil should be prepared before planting, as it is for any cultivated crop. Tree rows should be at least 16 feet apart. The windbreak ordinarily should not be located nearer than 100 feet and not more than 300 feet away from the area where protection is desired. The trees should be carefully cultivated during the first few years until they are well established. Good-quality planting stock

and fire protection are necessary. Perhaps the greatest damage to windbreaks is caused by livestock, and for this reason fencing is needed. Because deer and rabbits can also damage young plants, chemical repellents should be used for the first few years for protection.

Evergreen trees that are suitable for planting in the survey area are Rocky Mountain juniper, ponderosa pine, Austrian pine, Colorado blue spruce, lodgepole pine, and white fir. Colorado blue spruce and lodgepole pine are more suitable for Lake County than for Chaffee County.

Broadleaf trees suitable for planting are native cottonwood, aspen, willow, and Siberian elm. Aspen is more suitable for Lake County than for Chaffee County.

Shrubs suitable for planting are chokecherry, Russian-olive, caragana, and squawbush.

#### Wildlife<sup>4</sup>

Wildlife, once essential for the survival of the Indians, explorers, and settlers, is now primarily important for recreational and esthetic purposes. For wildlife habitat, the environment must supply certain needs common to all animals. Among these basic requirements are places for feeding, resting, sleeping, hiding, breeding, and rearing of young. The degree to which these requirements are met largely determines the kinds and numbers of wildlife populations.

Table 3 indicates the suitability of each of the 10 soil associations to provide habitat for specified kinds of wildlife. The ratings indicate potential for wildlife, not necessarily present use. Because the soil associations contain many different kinds of soils, the ratings are general and do not necessarily apply to any given area. Onsite investigation should be made if wildlife development is planned. The general soil map at the back of this survey shows the location of the 10 soil associations in the survey area.

The soil associations are treated individually in the table, but it is important to realize that the position of one association in relation to that of another is important. It would be unusual if one soil association could furnish all the basic requirements for a given kind of wildlife. For example, one association can supply food and cover, whereas another can contain a source of water.

Elevations in the survey area range from about 7,000 feet to more than 14,000 feet. The many habitat types resulting from the differences in altitude enable a large number of wildlife species to live in this area. The major species considered in this survey are elk, mule deer, black bear, cottontail, jackrabbit, snowshoe hare, blue grouse, mourning dove, wild turkey, ptarmigan, and ducks. Several species of coldwater fish are found in the streams, lakes, and ponds, including rainbow trout, brown trout, brook trout, lake trout, and kokanee salmon.

Soils have characteristics that limit their ability to produce food, water, and cover for wildlife. Big sagebrush, four-wing saltbush, and willow are excellent sources of food for big game. Indian ricegrass, wheat-

<sup>4</sup> ELDIE W. MUSTARD, State biologist, Soil Conservation Service, helped prepare this section.

TABLE 3.—*Potential of soil associations to produce requirements for the more important wildlife species*

Soil association	Wildlife species	Potential for—				
		Protective and escape cover		Food	Aquatic environment	
		Woody	Herbaceous		Natural	Developed
1. Rock outcrop—Bross.	Snowshoe hare	Not applicable	Suited	Suited	Not applicable	Not applicable.
	Ptarmigan	Not applicable	Well suited	Well suited	Not applicable	Not applicable.
2. Troutville—Leadville.	Deer	Well suited	Not applicable	Suited	Not applicable	Not applicable.
	Elk	Well suited	Not applicable	Suited	Not applicable	Not applicable.
3. Rock land—Rock outcrop.	Bear	Well suited	Not applicable	Suited	Not applicable	Not applicable.
	Snowshoe hare	Well suited	Poorly suited	Suited	Not applicable	Not applicable.
	Blue grouse	Well suited	Poorly suited	Suited	Not applicable	Not applicable.
	Waterfowl	Not applicable	Not applicable	Poorly suited	Poorly suited	Not applicable.
	Fish	Not applicable	Not applicable	Not applicable	Well suited	Poorly suited.
	Deer	Well suited	Not applicable	Suited	Not applicable	Not applicable.
	Elk	Well suited	Not applicable	Poorly suited	Not applicable	Not applicable.
	Bear	Well suited	Not applicable	Poorly suited	Not applicable	Not applicable.
	Cottontail	Well suited	Poorly suited	Suited	Not applicable	Not applicable.
	Turkey	Suited	Not applicable	Suited	Not applicable	Not applicable.
4. St. Elmo—Manhattan.	Mourning dove	Well suited	Not applicable	Poorly suited	Not applicable	Not applicable.
	Deer	Poorly suited	Not applicable	Suited	Not applicable	Not applicable.
	Elk	Poorly suited	Not applicable	Well suited	Not applicable	Not applicable.
	Cottontail	Suited	Well suited	Well suited	Not applicable	Not applicable.
	White-tailed jackrabbit.	Not applicable	Not applicable	Well suited	Not applicable	Not applicable.
5. Dominson—San Isabel.	Mourning dove	Well suited	Not applicable	Suited	Not applicable	Not applicable.
	Waterfowl	Not applicable	Not applicable	Poorly suited	Not applicable	Poorly suited.
	Fish	Not applicable	Not applicable	Not applicable	Not applicable	Poorly suited.
	Deer	Suited	Not applicable	Poorly suited	Not applicable	Not applicable.
	Elk	Suited	Not applicable	Poorly suited	Not applicable	Not applicable.
	Cottontail	Suited	Suited	Suited	Not applicable	Not applicable.
	White-tailed jackrabbit.	Not applicable	Not applicable	Poorly suited	Not applicable	Not applicable.
	Turkey	Suited	Poorly suited	Poorly suited	Not applicable	Not applicable.
	Mourning dove	Suited	Not applicable	Poorly suited	Not applicable	Not applicable.
	Fish	Not applicable	Not applicable	Not applicable	Well suited	Poorly suited.
6. Cotopaxi—Ouray.	Deer	Poorly suited	Not applicable	Poorly suited	Not applicable	Not applicable.
	Cottontail	Poorly suited	Poorly suited	Poorly suited	Not applicable	Not applicable.
7. Pierian—Poncha.	Mourning dove	Poorly suited	Not applicable	Suited	Not applicable	Not applicable.
	Deer	Suited	Not applicable	Suited	Not applicable	Not applicable.
8. Rough broken land—Badland.	Elk	Well suited	Not applicable	Suited	Not applicable	Not applicable.
	Cottontail	Suited	Suited	Suited	Not applicable	Not applicable.
	Snowshoe	Well suited	Suited	Suited	Not applicable	Not applicable.
	Bear	Well suited	Not applicable	Suited	Not applicable	Not applicable.
	Blue grouse	Well suited	Suited	Well suited	Not applicable	Not applicable.
	Mourning dove	Suited	Not applicable	Poorly suited	Not applicable	Not applicable.
	Fish	Not applicable	Not applicable	Not applicable	Well suited	Poorly suited.
	Deer	Well suited	Not applicable	Suited	Not applicable	Not applicable.
	Elk	Well suited	Not applicable	Poorly suited	Not applicable	Not applicable.
	Bear	Well suited	Not applicable	Poorly suited	Not applicable	Not applicable.
9. Well alluvial land—Gas Creek.	Cottontail	Well suited	Poorly suited	Suited	Not applicable	Not applicable.
	White-tailed jackrabbit.	Not applicable	Not applicable	Suited	Not applicable	Not applicable.
	Turkey	Suited	Poorly suited	Poorly suited	Not applicable	Not applicable.
	Mourning dove	Well suited	Not applicable	Poorly suited	Not applicable	Not applicable.
	Deer	Suited	Not applicable	Suited	Not applicable	Not applicable.
	Elk	Suited	Not applicable	Well suited	Not applicable	Not applicable.
	Cottontail	Well suited	Well suited	Well suited	Not applicable	Not applicable.
	Mourning dove	Suited	Not applicable	Suited	Not applicable	Not applicable.
	Blue grouse	Well suited	Well suited	Well suited	Not applicable	Not applicable.
	Waterfowl	Not applicable	Not applicable	Well suited	Suited	Not applicable.
10. Newfork—Marsh—Rosane.	Fish	Not applicable	Not applicable	Not applicable	Well suited	Suited.
	Deer	Suited	Not applicable	Suited	Not applicable	Not applicable.
	Elk	Suited	Not applicable	Well suited	Not applicable	Not applicable.
	Cottontail	Well suited	Well suited	Well suited	Not applicable	Not applicable.
	White-tailed jackrabbit.	Not applicable	Not applicable	Suited	Not applicable	Not applicable.
	Blue grouse	Well suited	Well suited	Well suited	Not applicable	Not applicable.
	Mourning dove	Suited	Not applicable	Suited	Not applicable	Not applicable.
	Waterfowl	Not applicable	Not applicable	Well suited	Well suited	Not applicable.
	Fish	Not applicable	Not applicable	Not applicable	Suited	Poorly suited.

grass, fescue, bluegrass, and brome grass also furnish food for wildlife, as do vetch, clover, aster, cinquefoil, and paintbrush. In addition, other herbaceous plants furnish food and, to a lesser extent, cover for wildlife. Pinyon pine, juniper, big sagebrush, rubber rabbitbrush, four-wing saltbush, currant, and willow furnish cover for wildlife.

The degrees of suitability of the soil for wildlife as used in table 3 are well suited, suited, and poorly suited. The degree of suitability needs to be considered when planning wildlife habitat developments.

*Well suited* for protective and escape cover and food indicates that soil conditions are favorable for establishment, for vigorous growth, and for the reproduction of many kinds of climatically adapted plants that are used by wildlife. Rates of growth and seed production are above average. For aquatic environment, well suited indicates that soil conditions are favorable for water areas or for the construction and maintenance of water areas requiring control of the water level.

*Suited* for protective and escape cover and food indicates that soil conditions are suitable for a dependable growth of a number of adapted plants. Rates of growth and seed production are about average. For aquatic environment, suited indicates that soil conditions either somewhat limit natural water areas because of unreliable water sources or that they present difficulties in creating or maintaining water areas.

*Poorly suited* for protective and escape cover and food indicates that soil conditions severely limit the number of plants. The rates of growth and seed production are below average. For aquatic environment, poorly suited indicates that soil conditions severely limit the choice of measures, that they present serious construction problems, or that they pose major difficulties in creating or maintaining water areas.

## Engineering Uses of the Soils

This section is useful to those who need information about soils used as structural material or as foundation upon which structures are built. Among those who can benefit from this section are planning commissions, town and city managers, land developers, engineers, contractors, and farmers.

Among properties of soils highly important in engineering are permeability, strength, compaction characteristics, soil drainage condition, shrink-swell potential, grain size, plasticity, and soil reaction. Also important are depth to the water table, depth to bedrock, and soil slope. These properties, in various degrees and combinations, affect construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

Information in this section of the soil survey can be helpful to those who—

1. Select potential residential, industrial, commercial, and recreational areas.
2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Seek sources of gravel, sand, or clay.

4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of the kinds of soil on which they are built, for the purpose of predicting performance of structures on the same or similar kinds of soil in other locations.
6. Predict the trafficability of soils for cross-country movement of vehicles and construction equipment.
7. Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables 4 and 5, which show, respectively, several estimated soil properties significant to engineering and interpretations for various engineering uses.

This information, along with the soil map and other parts of this publication, can be used to make interpretations in addition to those given in tables 4 and 5, and it also can be used to make other useful maps.

This information, however, does not eliminate the need for further investigations at sites selected for engineering works, especially works that involve heavy loads or that require excavations to depths greater than those shown in the tables, generally depths greater than 6 feet. Also, inspection of sites, especially the small ones, is needed because many delineated areas of a given soil mapping unit may contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some of the terms used in this soil survey have special meaning to soil scientists that is not known to all engineers. The Glossary defines many of these terms commonly used in soil science.

## Engineering soil classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified system used by the SCS engineers, Department of Defense, and others, and the AASHTO system adopted by the American Association of State Highway Officials.

The Unified system (8) is used to classify soils according to those properties that affect use of the soil as a construction material, as in a dam, or when used as a foundation material for a structure, such as a building. In this system soils are classified according to particle-size distribution, plasticity, liquid limit, and organic-matter content. Soils are grouped in 15 classes. There are eight classes of coarse-grained soils. The dominantly gravelly soils are identified as GW, GP, GM, and GC, and the dominantly sandy soils are SW, SP, SM, and SC. There are six classes of fine-grained soils. Those with low liquid limits are identified as ML, CL, and OL, and those with high liquid limits are MH, CH, and OH. There is one class of highly organic soils, identified as Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example, CL-ML.

The AASHTO system (1, 4) is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system, a



TABLE 4.—*Estimated soil properties*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. the instructions for referring to other series that appear in the

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	USDA texture
	<i>Ft</i>	<i>In</i>	
Adilis: AdC.....	1-2	0-4 4-17 17-23 23-60	Loam..... Coarse sandy loam..... Gravelly sandy loam..... Sand, gravel, and cobbles.....
Antero: AnB.....	0-1	0-14 14-20 20-54 54-60	Sandy loam..... Loamy coarse sand..... Sandy loam..... Gravel and cobbles.....
Badland: Ba..... Too variable for valid estimates to be made.	( <sup>1</sup> )		
Blanyon: BIB.....	( <sup>1</sup> )	0-8 8-22 22-60	Clay loam..... Silty clay loam..... Silty clay.....
Bross: BrF.....	( <sup>1</sup> )	0-60	Very cobbly sandy loam.....
Cabin: CaE.....	( <sup>1</sup> )	0-6 6-22 22-60	Gravelly sandy loam..... Gravelly fine sandy clay loam..... Very cobbly loamy fine sand.....
Chaffee: ChB.....	0-1	0-40 40-60	Loam and fine sandy loam..... Sand, gravel, and cobbles.....
Collegiate: ClB.....	2-3	0-4 4-9 9-36 36-60	Loam..... Sandy clay loam..... Sandy loam..... Gravel and cobbles.....
Costilla: CoD.....	( <sup>1</sup> )	0-21 21-60	Gravelly coarse sandy loam..... Gravelly coarse sand.....
Cotopaxi: ClD.....	( <sup>1</sup> )	0-3 3-60	Loamy fine sand..... Fine sand.....
Dominson: DoD, DoF.....	( <sup>1</sup> )	0-11 11-60	Gravelly sandy loam..... Cobbles, gravel, and sand.....
Gas Creek: GcB.....	0-1	0-13 13-60	Gravelly sandy loam..... Cobbles, gravel, and sand.....
Granile: GrE.....	( <sup>1</sup> )	0-18 18-27 27-41 41-60	Gravelly sandy loam..... Very gravelly clay loam..... Very gravelly loam..... Weathered granite.....
Grantsdale: GsD.....	( <sup>1</sup> )	0-4 4-18 18-27 27-60	Fine sandy loam..... Sandy clay loam..... Loam..... Gravelly fine sand.....
Gravelly alluvial land: Gv..... Too variable for valid estimates to be made.	( <sup>1</sup> )		
Hawksell: HaD.....	( <sup>1</sup> )	0-26 26-60	Sandy loam..... Loamy sand.....
Keeldar: KeC.....	( <sup>1</sup> )	0-55 55-60	Gravelly sandy loam..... Gravel and cobbles.....

*significant to engineering*

The soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully first column of this table. The symbol > means more than]

Classification		Coarse fraction greater than 3 inches	Percentage less than 3 inches passing sieve—				Permeability	Available water capacity	Reaction	Shrink-swell potential
Unified	AASHO		No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)				
		<i>Pct</i>					<i>In per hr</i>	<i>In per in of soil</i>	<i>pH</i>	
ML	A-4	-----	90-100	90-100	85-90	60-75	0.6-2.0	0.16-0.18	6.6-7.3	Low.
SM	A-2	0-10	85-95	85-90	50-60	25-35	2.0-6.0	0.11-0.13	6.6-7.3	Low.
SM	A-2 or A-1	0-50	55-65	65-75	40-50	20-30	2.0-6.0	0.07-0.09	6.6-7.3	Low.
GP	A-1	45-75	20-50	10-45	5-10	0-5	6.0-20.0	0.04-0.06	6.6-7.3	Low.
SM	A-2 or A-4	-----	90-100	85-100	50-70	30-40	2.0-6.0	0.11-0.13	7.4-8.4	Low.
SM	A-2	-----	90-100	85-95	50-75	10-15	2.0-6.0	0.05-0.07	7.4-8.4	Low.
SM	A-2 or A-4	-----	90-100	85-100	75-85	30-40	2.0-6.0	0.11-0.13	7.9-8.4	Low.
GP	A-1	45-75	20-50	10-45	5-10	0-5	>20.0	0.03-0.05	7.4-8.4	Low.
CL	A-7	-----	90-100	90-95	80-90	70-80	0.06-0.2	0.19-0.21	7.9-8.4	Moderate.
CL	A-7	-----	90-100	90-100	90-95	85-95	0.06-0.2	0.19-0.21	7.9-8.4	Moderate.
CH	A-7	-----	95-100	95-100	95-100	90-95	0.06-0.2	0.15-0.17	7.9-8.4	High.
SM	A-1	50-70	70-80	65-75	35-45	20-25	2.0-6.0	0.09-0.10	4.5-5.5	Low.
SM	A-1	0-10	65-75	60-70	35-45	20-45	2.0-6.0	0.07-0.09	6.1-7.3	Low.
SC	A-2 or A-6	10-20	75-90	65-80	55-75	25-45	0.6-2.0	0.11-0.13	6.6-7.3	Low.
SM	A-1	55-80	65-75	60-70	30-50	10-20	6.0-20.0	0.05-0.07	6.6-7.3	Low.
ML	A-4	-----	90-100	90-100	80-85	50-55	0.6-2.0	0.15-0.17	6.6-7.8	Low.
GP	A-1	45-75	20-50	10-45	5-15	0-5	6.0-20.0	0.03-0.05	6.6-7.8	Low.
ML	A-4	-----	85-95	85-95	80-85	55-60	0.6-2.0	0.16-0.18	6.6-7.8	Low.
SC	A-6	-----	90-95	85-90	80-85	40-45	0.6-2.0	0.14-0.16	6.6-7.8	Low.
SM	A-2 or A-4	-----	85-95	85-90	70-80	30-45	0.6-2.0	0.11-0.13	6.6-7.8	Low.
GP	A-1	45-75	20-50	10-45	5-15	0-5	6.0-20.0	0.03-0.05	6.6-7.8	Low.
SM	A-1 or A-2	0-40	80-90	75-85	45-55	20-30	2.0-6.0	0.07-0.09	6.6-8.4	Low.
SP	A-1	0-25	70-80	65-75	25-35	0-5	6.0-20.0	0.04-0.06	7.9-9.0	Low.
SM	A-2	0-10	90-100	90-95	50-75	20-35	2.0-6.0	0.09-0.10	6.6-7.8	Low.
SM	A-2	0-10	90-100	90-95	50-70	20-30	6.0-20.0	0.05-0.07	7.4-7.8	Low.
SM	A-1 or A-2	0-50	65-85	65-75	35-50	20-30	2.0-6.0	0.07-0.09	6.6-7.8	Low.
GP	A-1	45-75	20-50	10-45	0-10	0-5	>20.0	0.03-0.05	6.6-7.8	Low.
SM	A-1 or A-2	0-45	75-85	60-75	35-50	20-30	2.0-6.0	0.07-0.09	6.6-7.3	Low.
GP	A-1	45-75	20-50	10-45	5-10	0-5	>20.0	0.03-0.05	6.6-7.3	Low.
SM	A-1	0-30	70-80	60-75	20-30	15-20	2.0-6.0	0.07-0.09	5.6-6.5	Low.
GC	A-1 or A-2	15-45	40-50	30-40	25-35	20-30	0.6-2.0	0.13-0.15	6.1-7.3	Low.
GM	A-1	0-45	25-35	25-35	20-30	15-25	2.0-6.0	0.07-0.09	6.6-7.3	Low.
SM	A-4	-----	90-100	90-100	75-85	40-50	2.0-6.0	0.13-0.15	6.6-7.8	Low.
SC	A-6	-----	90-100	85-95	80-90	40-50	0.6-2.0	0.14-0.16	7.4-8.4	Low.
ML	A-4	-----	90-100	85-95	80-90	55-65	0.6-2.0	0.16-0.18	7.9-8.4	Low.
SM	A-1 or A-2	25-40	75-85	50-65	45-60	15-20	6.0-20.0	0.04-0.06	7.9-8.4	Low.
SM	A-2	-----	90-100	85-95	50-60	25-35	0.6-2.0	0.11-0.13	7.9-8.4	Low.
SM	A-2 or A-1	-----	90-100	85-90	45-60	15-25	2.0-6.0	0.06-0.08	7.9-9.0	Low.
SM	A-1 or A-2	0-25	70-85	65-80	40-50	20-30	6.0-20.0	0.07-0.09	7.4-9.0	Low.
GP	A-1	45-75	20-50	10-45	5-10	0-5	>20.0	0.03-0.05	7.9-9.0	Low.

TABLE 4.—*Estimated soil properties*

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	USDA texture
	<i>Ft</i>	<i>In</i>	
Leadville: LeE.....	( <sup>1</sup> )	0-8 8-14 14-60	Sandy loam..... Sandy clay loam..... Clay loam.....
Manhattan: MaB, MaD.....	( <sup>1</sup> )	0-16 16-37 37-60	Sandy loam..... Gravelly sandy loam..... Cobbles, gravel, and sand.....
Marsh: Mh..... Too variable for valid estimates to be made.	0-1½		
Mine pits and dumps: Mp..... Too variable for valid estimates to be made.	( <sup>1</sup> )		
Newfork: NfB.....	0-1	0-12 12-60	Gravelly sandy loam..... Cobbles, gravel, and sand.....
Ouray: OrC.....	( <sup>1</sup> )	0-25 25-60	Sandy loam..... Sand.....
Ouray, thick surface variant: OuB.....	( <sup>1</sup> )	0-8 8-20 20-60	Gravelly loam..... Gravelly sandy loam..... Sandy loam.....
Pando: PaD.....	( <sup>1</sup> )	0-30 30-60	Gravelly sandy loam..... Gravel and cobbles.....
Peat: Pe.....	0-1½	60-0	Peat.....
Pierian: PgD, PIF.....	( <sup>1</sup> )	0-9 9-60	Gravelly sandy loam..... Boulders, cobbles, gravel, and sand.....
Placer diggings and tailings: Pn..... Too variable for valid estimates to be made.	( <sup>1</sup> )		
Poncha: PoC.....	>5	0-20 20-60	Gravelly sandy loam..... Cobbles, gravel, and sand.....
*Rock land: RcF, RgE, RkF. Too variable for valid estimates to be made. For Gravelly land in RgE, see Gravelly alluvial land; for Stecum soil in RkF, see Stecum series.			
Rock outcrop: Ro. Too variable for valid estimates to be made.			
Rock slides: Rs. Too variable for valid estimates to be made.			
Rosane: RtC.....	0-1	0-30 30-60	Loam and sandy loam..... Gravel, cobbles, and sand.....
Rough broken land: Ru, Rv. Too variable for valid estimates to be made.			
St. Elmo: SeB, SeD, SeF.....	( <sup>1</sup> )	0-10 10-20 20-60	Gravelly sandy loam..... Gravelly and cobbly loamy sand..... Gravel, cobbles, and sand.....
San Isabel: SsC.....	( <sup>1</sup> )	0-19 19-60	Gravelly sandy loam..... Cobbles, gravel, and sand.....
Sawatch: StC.....	0-1	0-28 28-60	Sandy loam..... Gravel, cobbles, and sand.....

significant to engineering—Continued

Classification		Coarse fraction greater than 3 inches	Percentage less than 3 inches passing sieve—				Permeability	Available water capacity	Reaction	Shrink-swell potential
Unified	AASHO		No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)				
		<i>Pct</i>					<i>In per hr</i>	<i>In per in of soil</i>	<i>pH</i>	
SM	A-2	0-10	85-90	85-90	55-65	25-35	0.6-2.0	0.11-0.13	5.6-6.5	Low.
SC	A-6	5-40	85-95	85-90	70-80	35-45	0.6-2.0	0.11-0.13	6.1-7.3	Moderate.
CL	A-6	60-90	85-90	85-90	75-85	60-70	0.2-0.6	0.10-0.12	6.1-7.3	Low.
SM	A-2	-----	90-95	85-90	50-60	25-35	2.0-6.0	0.11-0.13	6.6-7.8	Low.
SM	A-1 or A-2	0-25	75-85	65-75	40-35	20-30	2.0-6.0	0.07-0.09	7.9-8.4	Low.
GP	A-1	45-75	20-50	10-45	5-10	0-5	>20.0	0.03-0.05	-----	Low.
SM	A-1	25-55	50-65	50-65	30-45	15-20	6.0-20.0	0.07-0.09	6.6-7.3	Low.
GP	A-1	45-75	20-50	10-45	5-10	0-5	>20.0	0.03-0.05	-----	Low.
SM	A-2	-----	95-100	90-95	60-70	25-35	2.0-6.0	0.11-0.13	6.6-7.8	Low.
SP-SM	A-3	-----	95-100	90-95	50-65	5-10	6.0-20.0	0.05-0.07	6.6-7.8	Low.
SM or ML	A-4	0-15	75-85	65-75	55-70	40-55	0.6-2.0	0.10-0.12	7.4-7.8	Low.
SM	A-1 or A-2	0-15	75-85	65-75	40-50	20-30	2.0-6.0	0.07-0.09	7.4-7.8	Low.
SM	A-2	0-5	90-100	80-90	50-60	25-35	0.6-2.0	0.11-0.13	7.4-7.8	Low.
SM	A-1	20-55	65-75	50-60	30-40	15-20	2.0-6.0	0.07-0.09	5.6-7.3	Low.
GP	A-1	45-75	20-50	10-45	5-10	0-5	>20.0	0.03-0.05	6.1-7.3	Low.
Pt	A-8	-----	-----	-----	-----	-----	2.0-6.0	0.22-0.25	6.1-7.3	Low.
SM	A-1	0-35	50-60	50-60	30-40	15-20	2.0-6.0	0.07-0.09	6.1-7.3	Low.
GP	A-1	45-75	20-50	10-45	0-5	0-5	>20.0	0.03-0.05	-----	Low.
SM	A-1 or A-2	0-15	55-75	50-70	30-50	15-30	2.0-6.0	0.07-0.09	6.6-9.0	Low.
GP	A-1	45-75	20-50	10-45	5-10	0-5	>20.0	0.03-0.05	7.4-9.0	Low.
SM	A-2	-----	90-100	85-95	55-60	20-35	2.0-6.0	0.12-0.14	6.6-7.3	Low.
GP	A-1	45-75	20-50	10-45	5-15	0-5	>20.0	0.03-0.05	-----	Low.
SM	A-1 or A-2	-----	70-80	60-70	40-50	20-30	2.0-6.0	0.07-0.09	7.9-8.4	Low.
SM	A-1	25-70	50-75	50-70	25-35	15-20	6.0-20.0	0.05-0.07	7.9-8.4	Low.
GP	A-1	45-75	20-50	10-45	5-10	0-5	>20.0	0.03-0.05	-----	Low.
SM	A-1 or A-2	25-60	60-80	60-70	35-50	20-30	2.0-8.0	0.07-0.09	6.6-7.3	Low.
GP	A-1	45-75	20-50	10-45	5-15	0-5	>20.0	0.03-0.05	-----	Low.
SM	A-2	-----	90-100	85-95	50-65	25-35	2.0-6.0	0.11-0.13	6.6-7.3	Low.
GP	A-1	45-75	20-50	10-45	5-15	0-5	>20.0	0.03-0.05	-----	Low.

TABLE 4.—*Estimated soil properties*

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	USDA texture
	<i>Ft</i>	<i>In</i>	
Shrine: SuD..... Slickens: Sw. Too variable for valid estimates to be made.	( <sup>1</sup> )	0-60	Clay loam.....
Stecum..... Mapped only with Rock land.	( <sup>1</sup> )	0-5 5-32 32-40	Sandy loam..... Gravelly loamy coarse sand..... Granite.
*Tigiwon: TgE..... For Turret soil, see Turret series.	( <sup>1</sup> )	0-18 18-60	Cobbly sandy loam..... Gravel, cobbles, and sand.....
Tomichi: ToE.....	( <sup>1</sup> )	0-7 7-13 13-60	Sandy loam..... Gravelly sandy loam..... Gravelly sand and cobbles.....
Troutville: TrE.....	( <sup>1</sup> )	0-14 14-40 40-60	Gravelly sandy loam..... Sandy loam..... Cobbles and gravel.....
Turret..... Mapped only with Tigiwon soils.	( <sup>1</sup> )	0-7 7-16 16-60	Cobbly sandy loam..... Cobbly sandy clay loam..... Cobbly sandy loam.....
Wet alluvial land: Wa. Too variable for valid estimates to be made.			

<sup>1</sup> No water table was encountered to the depth of observation, usually to a depth of 5 feet or to bedrock.



significant to engineering—Continued

Classification		Coarse fraction greater than 3 inches	Percentage less than 3 inches passing sieve—				Permeability	Available water capacity	Reaction	Shrink-swell potential
Unified	AASHO		No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)				
CH	A-7	Pct	85-100	85-95	80-95	65-80	In per hr 0.2-0.6	In per in of soil 0.19-0.21	ph 7.9-9.0	High.
SM	A-1 or A-2	0-10	85-95	85-95	50-65	25-40	2.0-6.0	0.11-0.13	6.6-7.3	Low.
SP-SM	A-1	15-50	75-85	60-75	30-40	5-10	6.0-20.0	0.04-0.06	6.6-7.3	Low.
SM	A-1	0-40	65-75	60-70	35-50	15-25	2.0-8.0	0.07-0.09	6.6-8.4	Low.
GP	A-1	45-75	20-50	10-45	5-10	0-5	>20.0	0.03-0.05	7.4-8.4	Low
SM	A-2	0-10	85-95	85-95	50-65	25-35	2.0-6.0	0.11-0.13	5.6-6.5	Low.
SM	A-1 or A-2	10-40	75-85	75-85	45-60	20-30	6.0-20.0	0.07-0.09	5.6-6.5	Low.
SP-SM	A-1	10-40	75-85	75-85	20-30	5-10	>20.0	0.04-0.06	5.6-6.5	Low.
SM	A-1 or A-2	10-30	60-80	60-80	35-55	20-30	2.0-6.0	0.07-0.09	6.1-7.3	Low.
SM	A-1 or A-2	40-70	60-80	60-80	20-30	20-30	2.0-6.0	0.06-0.08	6.1-7.3	Low.
GP	A-1	45-75	20-50	10-45	5-10	0-5	>20.0	0.03-0.05	-----	Low.
SM	A-2	10-35	85-95	75-85	45-60	25-35	2.0-6.0	0.07-0.09	6.6-7.3	Low.
SC	A-6	10-35	85-95	70-80	55-70	35-45	0.6-2.0	0.13-0.15	6.6-7.3	Low.
SM	A-1 or A-2	40-80	80-90	70-80	40-55	20-30	2.0-6.0	0.06-0.08	6.6-7.3	Low.

soil is placed in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A-1 are gravelly soils of high bearing strength, or the best soils for subgrade (foundation). At the other extreme, in group A-7, are clay soils that have low strength when wet and that are the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A-1, A-2 and A-7 groups are divided as follows: A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, and A-7-6. As additional refinement, the engineering value of a soil material can be indicated by a group index number. Group indexes range from 0 for the best material to 20 or more for the poorest. The estimated AASHTO classification, without group index numbers, is given in table 4 for all soils mapped in the survey area. No soil samples were collected in this area for laboratory analyses.

#### **Soil properties significant to engineering**

Several estimates of soil properties significant to engineering are given in table 4. These estimates are made by layers of the soil having significantly different properties. The estimates are based on field observations made in the course of mapping, on test data for similar soils, and on experience with the same kinds of soil in other counties. Following are explanations of some of the columns in table 4.

Depth to bedrock is the distance from the surface of the soil to the rock layer within the depth of observation. It is not given in table 4, because bedrock is at a depth of more than 5 feet in all soils except the Granile and Stecum soils. It is at a depth of 3½ to 5 feet in the Granile soils and 2 to 3½ feet in the Stecum soils.

Depth to seasonal high water table is the distance from the surface of the soil to the highest level that ground water reaches in the soil in most years.

Soil texture is described in table 4 in the standard terms used by the Department of Agriculture. These terms are based on the percentage of sand, silt, and clay in the less than 2-millimeter fraction of the soil. "Loam," for example, is soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the soil contains gravel or other particles coarser than sand, an appropriate modifier is added, as for example, "gravelly loamy sand." "Sand," "silt," "clay," and some of the other terms used in USDA textural classification are defined in the Glossary.

Permeability is the ability of a soil to transmit water under gravity and a 1-inch head. It is controlled by the amount, the size, and the continuity of pores in the soil. The estimates in table 5 do not take into account such transient soil features as plowpans and surface crusts.

Available water capacity is the ability of soils to hold water for use by most plants. It is defined here as the difference between the amount of water in the soil at field capacity and the amount at the wilting point of most plants.

Reaction is a measure of the acidity or alkalinity of

a soil, expressed in pH values. Terms used to describe soil reaction are explained in the Glossary.

Shrink-swell potential is the relative change in volume to be expected of soil material with changes in moisture content, that is, the extent to which the soil shrinks as it dries out or swells when it gets wet. Extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils may damage building foundations, roads, and other structures. Soils having a *high* shrink-swell potential are potentially the most hazardous.

#### **Engineering interpretations of soils**

The estimated interpretations in table 5 are based on the engineering properties of soils shown in table 4, on test data for soils in survey areas nearby or adjoining, and on the experience of engineers and soil scientists with the soils of the Chaffee-Lake Area. In table 5, ratings are used to summarize limitation or suitability of the soils for all listed purposes other than for embankments, dikes, and levees, drainage of cropland and pasture, and irrigation. For these particular uses, table 5 lists those soil features not to be overlooked in planning, installation, and maintenance.

Soil limitations are indicated by the ratings slight, moderate, and severe. *Slight* means soil properties generally are favorable for the rated use or, in other words, limitations that are minor and easily overcome. *Moderate* means some soil properties are unfavorable but can be overcome or modified by special planning and design. *Severe* means soil properties are so unfavorable and so difficult to correct or overcome as to require major soil reclamation, special design, or intensive maintenance.

Soil suitability is rated by the terms *good*, *fair*, and *poor*, which have, respectively, meanings approximately parallel to the terms slight, moderate, and severe.

Following are explanations of the columns in table 5.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into natural soil. The soil material from a depth of 18 inches to 6 feet is evaluated. The soil properties considered are those that affect both absorption of effluent and construction and operation of the system. Properties that affect absorption are permeability, depth to water table or rock, and susceptibility to flooding. Slope is a soil property that affects difficulty of layout and construction and also the risk of soil erosion, lateral seepage, and downslope flow of effluent. Large rocks or boulders increase construction costs.

Sewage lagoons are shallow ponds constructed to hold sewage within a depth of 2 to 5 feet long enough for bacteria to decompose the solids. A lagoon has a nearly level floor, and sides, or embankments, of compacted soil material. The assumption is made that the embankment is compacted to medium density and the pond is protected from flooding. Properties are considered that affect the pond floor and the embankment. Those that affect the pond floor are permeability, organic-matter content, and slope, and if the floor needs to be leveled, depth to bedrock becomes

important. The soil properties that affect the embankment are the engineering properties of the embankment material as interpreted from the Unified classification and the amount of stones, if any, that influence the ease of excavation and compaction of the embankment material.

Shallow excavations are those that require digging or trenching to a depth of less than 6 feet, as for example, excavations for pipelines, sewer lines, phone and power transmission lines, basements, open ditches, and cemeteries. Desirable soil properties are good workability, moderate resistance to sloughing, gentle slopes, absence of rock outcrops or big stones, and freedom from flooding or a high water table.

Dwellings, as rated in table 5, are not more than three stories high and are supported by foundation footings placed in undisturbed soil. The features that affect the rating of a soil for dwellings are those that relate to capacity to support load and resist settlement under load and those that relate to ease of excavation. Soil properties that affect capacity to support load are wetness, susceptibility to flooding, density, plasticity, texture, and shrink-swell potential. Those that affect excavation are wetness, slope, depth to bedrock, and content of stones and rocks.

Local roads and streets, as rated in table 5, have an all-weather surface expected to carry automobile traffic all year. They have a subgrade of underlying soil material; a base consisting of gravel, crushed rock, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand, and most cuts and fills are less than 6 feet deep.

Soil properties that most affect design and construction of roads and streets are load-supporting capacity and stability of the subgrade and the workability and quantity of cut and fill material available. The AASHTO and Unified classifications of the soil material, and also the shrink-swell potential, indicate traffic-supporting capacity. Wetness and flooding affect stability of the material. Slope, depth to hard rock, content of stones and rocks, and wetness affect ease of excavation and amount of cut and fill needed to reach an even grade.

Campsites are used intensively for tents and small camp trailers and the accompanying activities of outdoor living. Little preparation of the site is required, other than shaping and leveling for tent and parking areas. Campsites are subject to heavy foot traffic and limited vehicular traffic. The best soils have mild slopes, good drainage, a surface free of rocks and coarse fragments, freedom from flooding during periods of heavy use, and a surface that is firm after rains but not dusty when dry.

Road fill is soil material used in embankments for roads. The suitability ratings reflect (1) the predicted performance of soil after it has been placed in an embankment that has been properly compacted and provided with adequate drainage and (2) the relative ease of excavating the material at borrow areas.

Sand and gravel are used in great quantities in many kinds of construction. The ratings in table 5 provide

guidance about where to look for probable sources. A soil rated as a *good* or *fair* source of sand or gravel generally has a layer at least 3 feet thick, the top of which is within a depth of 6 feet. The ratings do not take into account thickness of overburden, location of the water table, or other factors that affect mining of the materials, and neither do they indicate the quality of the deposit.

Topsoil is used for topdressing an area where vegetation is to be established and maintained. Suitability is affected mainly by ease of working and spreading the soil material, as for preparing a seedbed; natural fertility of the material, or the response of plants when fertilizer is applied; and absence of substances toxic to plants. Texture of the soil material and its content of stone fragments are characteristics that affect suitability, but also considered in the ratings is damage that will result at the area from which topsoil is taken.

Embankments, dikes, and levees require soil material resistant to seepage and piping and of favorable stability, shrink-swell potential, shear strength, and compactibility. Presence of stones or organic material in a soil are among factors that are unfavorable.

Drainage of cropland and pasture is affected by such soil properties as permeability, texture, and structure; depth to claypan, rock, or other layers that influence the rate of water movement; depth to the water table; slope; stability of the soil material in ditchbanks; susceptibility to stream overflow; salinity or alkalinity; and availability of outlets for drainage.

Irrigation of a soil is affected by such features as slope; susceptibility to stream overflow, water erosion, or soil blowing; soil texture; content of stones; accumulations of salts and alkali; depth of root zone; rate of water intake at the surface; permeability of soil layers below the surface layer and in fragipans or other layers that restrict movement of water; amount of water held available to plants; and need for drainage or depth to water table or bedrock.

## Formation and Classification of the Soils<sup>5</sup>

In this section the factors that affect the formation of the soils in the Chaffee-Lake Area are discussed and the major processes of soil formation are described. The classification of the soils into categories of the taxonomic system is given and the character of each of the categories is briefly described.

### Factors of Soil Formation

Soil is a natural body whose characteristics are the result of action by the forces of the environment upon parent materials over a period of time. Because it is a dynamic body, the character of the soil differs from place to place, depending upon the nature and intensity of the factors that controlled its development.

Five major factors are recognized as being influential in the development of the soil at any specific loca-

<sup>5</sup> By ARVAD J. CLINE, senior soil correlator, Soil Conservation Service.

TABLE 5.—*Interpretations of*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. the instructions for referring to other series

Soil series and map symbols	Degree and kind of limitations for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Local roads and streets	Campsites
Adilis: AdC.....	Severe: seasonal high water table.	Severe: rapid permeability; seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.
Antero: AnB.....	Severe: seasonal high water table.	Severe: rapid permeability; seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.
Badland: Ba.....	Severe: steep slopes.	Severe: steep slopes.	Severe: steep slopes.	Severe: steep slopes.	Severe: steep slopes.	Severe: steep slopes.
Blanyon: BiB.....	Severe: slow permeability.	Slight.....	Severe: too clayey.	Moderate: moderate to high shrink-swell potential.	Severe: high shrink-swell potential.	Moderate: silty clay loam surface layer.
Bross: BrF.....	Moderate where slopes are 9 to 15 percent. Severe where slopes are more than 15 percent. <sup>2</sup>	Severe: moderately rapid permeability; steep slopes.	Severe: high content of cobbles.	Moderate where slopes are 9 to 15 percent. Severe where slopes are more than 15 percent.	Moderate where slopes are 0 to 15 percent. Severe where slopes are more than 15 percent.	Severe: high content of cobbles; slope.
Cabin: CaE.....	Moderate where slopes are 9 to 15 percent. Severe where slopes are more than 15 percent. <sup>2</sup>	Severe: steep slopes.	Severe: high content of cobbles below a depth of 2 feet.	Moderate where slopes are 9 to 15 percent. Severe where slopes are more than 15 percent.	Moderate where slopes are less than 15 percent. Severe where slopes are more than 15 percent.	Moderate where slopes are 9 to 15 percent. Severe where slopes are more than 15 percent.
Chaffee: ChB.....	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.
Collegiate: CiB.....	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Moderate: seasonal high water table.	Moderate: seasonal high water table.	Moderate: seasonal high water table.
Costilla: CoD.....	Slight <sup>2</sup> .....	Severe: rapid permeability.	Severe: cut banks cave.	Slight.....	Slight.....	Moderate: high content of gravel.
Cotopaxi: CtD.....	Slight <sup>2</sup> .....	Severe: rapid permeability.	Severe: cut banks cave.	Slight.....	Slight.....	Moderate: loamy sand.

*engineering properties of the soils*

The soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully that appear in the first column of this table]

Suitability as a source of—				Soil features affecting—		
Road fill	Sand	Gravel	Topsoil	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation
Poor: poorly drained.	Poor _____	Good <sup>1</sup> _____	Poor: poorly drained.	High compacted permeability.	Seasonal high water table; rapid permeability.	Low available water capacity; seasonal high water table; moderately rapid permeability.
Poor: poorly drained.	Poor _____	Good <sup>1</sup> _____	Poor: poorly drained.	Medium compacted permeability; fair stability; medium piping hazard.	Seasonal high water table; moderately rapid permeability.	Moderate available water capacity; seasonal high water table.
Poor: steep slopes.	Unsuited _____	Unsuited _____	Unsuited _____	Steep slopes _____	Not applicable.	Not applicable.
Poor: high shrink-swell potential.	Unsuited _____	Unsuited _____	Poor: too clayey.	Low shear strength; fair compaction characteristics.	Slow permeability.	High available water capacity; slow permeability.
Fair: high content of cobbles; slope.	Unsuited _____	Unsuited _____	Poor: high content of cobbles.	High content of gravel and cobbles; poor compaction characteristics.	Not applicable.	Not applicable.
Fair: high content of cobbles; slope.	Unsuited _____	Unsuited _____	Poor: high content of gravel.	High content of gravel and cobbles below a depth of 2 feet; poor compaction characteristics.	Not applicable.	Not applicable.
Poor: poorly drained.	Unsuited _____	Good <sup>1</sup> _____	Poor: poorly drained.	High piping hazard; high compacted permeability below a depth of 40 inches.	Seasonal high water table; outlets difficult to find; moderate permeability.	Moderate available water capacity; seasonal high water table.
Fair: somewhat poorly drained.	Poor _____	Good <sup>1</sup> _____	Good _____	Medium piping hazard; high compacted permeability below a depth of 36 inches.	Seasonal high water table; moderate permeability.	Moderate available water capacity; seasonal high water table; moderate permeability.
Good _____	Good _____	Poor _____	Poor: high content of gravel.	High compacted permeability.	Favorable.	Low available water capacity; susceptible to soil blowing.
Slight _____	Poor _____	Unsuited _____	Poor: sandy.	High piping hazard; medium compacted permeability.	Favorable _____	Low available water capacity; susceptible to soil blowing; rapid permeability.

TABLE 5.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitations for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Local roads and streets	Campsites
Dominson: DoD, DoF.	Slight where slopes are 1 to 8 percent. <sup>2</sup> Moderate where slopes are 8 to 15 percent. <sup>2</sup> Severe where slopes are more than 15 percent. <sup>2</sup>	Severe: rapid permeability; slope.	Severe: high content of gravel; cut banks cave.	Slight where slopes are 1 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Slight where slopes are 1 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Moderate where slopes are 1 to 8 percent and gravelly. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.
Gas Creek: GcB.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.
Granile: GrE.	Severe: 40 to 60 inches deep over bedrock.	Severe: slope.	Severe: very gravelly; slope.	Slight where slopes are 3 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Slight where slopes are 3 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Moderate where slopes are 3 to 8 percent and gravelly. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.
Grantsdale: GsD	Slight <sup>2</sup>	Moderate: moderate permeability.	Severe: cut banks cave.	Slight	Slight	Slight where slopes are 3 to 8 percent. Moderate where slopes are more than 8 percent.
Gravelly alluvial land: Gv. <sup>3</sup>						
Hawksell: HaD.	Slight	Moderate: moderate permeability.	Moderate: cut banks cave.	Slight	Slight	Moderate: gravelly.
Keeldar: KeC.	Slight <sup>2</sup>	Severe: rapid permeability.	Moderate: high gravel content.	Slight	Slight	Slight
Leadville: LeE.	Severe: moderately slow permeability.	Severe: slope; high content of stones.	Severe: high content of stones.	Severe: high content of stones; slopes of more than 15 percent in some places.	Severe: high content of stones; slopes of more than 15 percent in some places.	Moderate where slopes are 3 to 15 percent. Severe where slopes are more than 15 percent; high content of stones.



*properties of the soils—Continued*

Suitability as a source of—				Soil features affecting—		
Road fill	Sand	Gravel	Topsoil	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation
Slight where slopes are 1 to 15 percent. Moderate where slopes are 15 to 25 percent. Severe where slopes are more than 25 percent.	Poor.....	Good <sup>1</sup> .....	Poor: high content of gravel.	High compacted permeability.	Favorable .....	Slopes are 1 to 9 percent; low available water capacity; shallow over gravel, cobbles, and sand.
Poor: poorly drained.	Poor.....	Good <sup>1</sup> .....	Poor: high content of gravel; poorly drained.	High compacted permeability.	Poor outlets; very rapid permeability.	Very rapid permeability; low available water capacity; seasonal high water table.
Slight where slopes are 3 to 15 percent. Moderate where slopes are 15 to 25 percent. Severe where slopes are more than 25 percent.	Unsuited.....	Poor <sup>1</sup> .....	Poor: high content of gravel.	Limited material; medium compacted permeability.	Not applicable.....	Not applicable.
Good.....	Poor.....	Poor <sup>1</sup> .....	Fair: sandy clay loam.	High piping hazard; medium compacted permeability.	Favorable .....	Moderate permeability and available water capacity.
Good.....	Poor.....	Unsuited.....	Good.....	High piping hazard.	Favorable.....	Moderate permeability and available water capacity.
Good.....	Poor.....	Good <sup>1</sup> .....	Poor: high content of gravel.	High compacted permeability.	Favorable.....	Low available water capac- ity; rapid permeability.
Poor; high content of stones.	Unsuited.....	Unsuited.....	Fair: high content of stones.	High content of stones; fair compaction character- istics.	Not applicable.	Not applicable.

TABLE 5.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitations for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Local roads and streets	Campsites
Manhattan: MaB, MaD.	Slight <sup>2</sup> .....	Severe: rapid permeability.	Severe: cut banks cave.	Slight.....	Slight.....	Slight.....
Marsh: Mh.....	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.
Mine pits and dumps: Mp.	( <sup>3</sup> ).....	( <sup>3</sup> ).....	( <sup>3</sup> ).....	( <sup>3</sup> ).....	( <sup>3</sup> ).....	( <sup>3</sup> ).....
Newfork: NfB.....	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.
Ouray: OrC.....	Slight <sup>2</sup> .....	Severe: moderately rapid permeability.	Severe: cut banks cave.	Slight.....	Slight.....	Slight.....
Ouray, thick surface variant: OuB.	Slight.....	Moderate: moderate permeability; excess humus.	Slight.....	Slight.....	Slight.....	Slight.....
Pando: PaD.....	Slight <sup>2</sup> .....	Severe: rapid permeability.	Severe: high content of gravel.	Slight.....	Slight.....	Moderate: high content of gravel.
Peat: Pe.....	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.
Pierian: PgD, PIF.	Severe: high content of stones; slope.	Severe: high content of stones; slope.	Severe: high content of stones.	Severe: high content of stones.	Severe: high content of stones.	Severe: high content of gravel.
Placer diggings and tailings: Pn.	( <sup>3</sup> ).....	( <sup>3</sup> ).....	( <sup>3</sup> ).....	( <sup>3</sup> ).....	( <sup>3</sup> ).....	Severe: high content of gravel, cobbles, and stones.
Poncha: PoC.....	Slight <sup>2</sup> .....	Severe: moderately rapid permeability.	Severe: cut banks cave; high content of gravel.	Slight.....	Slight.....	Moderate: high content of gravel.

*properties of the soils—Continued*

Suitability as a source of—				Soil features affecting—		
Road fill	Sand	Gravel	Topsoil	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation
Good.....	Poor.....	Good <sup>1</sup> .....	Fair: high content of gravel.	High compacted permeability.	Favorable.....	Low available water capac- ity; moder- ately rapid permeability.
Poor: very poorly drained. ( <sup>3</sup> ).....	Unsuited.....  ( <sup>3</sup> ).....	Unsuited.....  ( <sup>3</sup> ).....	Poor: very poorly drained.  Poor: high content of gravel and cobbles.	( <sup>3</sup> ).....  ( <sup>3</sup> ).....	No outlets.....  Not applicable.	Not applicable; high water table.  Not applicable.
Poor: poorly drained.	Poor.....	Good <sup>1</sup> .....	Poor: poorly drained.	High compacted permeability.	Outlets difficult to find; rapid permeability.	Low available water capac- ity; seasonal high water table; rapid permeability.
Good.....	Fair.....	Unsuited.....	Good.....	Medium compacted permeability; medium pip- ing hazard.	Favorable.....	Low available water capac- ity; suscep- tible to soil blowing; moderately rapid permeability.
Good.....	Poor.....	Unsuited.....	Good.....	Fair compaction character- istics; medium pip- ing hazard.	Favorable.....	Moderate available water capac- ity and permeability.
Good.....	Poor.....	Good <sup>1</sup> .....	Poor: high content of gravel.	High compacted permeability.	Favorable.....	Low available water capacity; moderately rapid permeability.
Poor: very poorly drained.	Unsuited.....	Unsuited.....	Poor: poorly drained.	Seasonal high water table.	Poor outlets.....	Seasonal high water table.
Poor: high content of stones.  ( <sup>3</sup> ).....	Poor.....  ( <sup>3</sup> ).....	Good <sup>1</sup> .....  ( <sup>3</sup> ).....	Poor: high content of gravel.  Poor: high content of gravel, cobbles, and stones.	High compacted permeability; high content of stones.  ( <sup>3</sup> ).....	Not applicable.....  Not applicable.....	Not applicable.  Not applicable.
Good.....	Poor.....	Good <sup>1</sup> .....	Poor: high content of gravel.	High compacted permeability.	Favorable.....	Low available water capacity; moderately rapid permeability.

TABLE 5.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitations for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Local roads and streets	Campsites
*Rock land: R <sub>c</sub> F, R <sub>k</sub> F, R <sub>g</sub> E. For Stecum soil in R <sub>k</sub> F, see Stecum series; for Gravelly land in R <sub>g</sub> E, see Gravelly alluvial land.	Severe: slope; shallow over bedrock.	Severe: slope; shallow over bedrock.	Severe: shallow over bedrock.	Severe: slope; shallow over bedrock.	Severe: shallow over bedrock.	Severe: slope; exposed bedrock.
Rock outcrop: R <sub>o</sub> .	Severe: exposed bedrock.	Severe: exposed bedrock.	Severe: exposed bedrock.	Severe: exposed bedrock.	Severe: exposed bedrock.	Severe: exposed bedrock.
Rock slides: R <sub>s</sub> .....	Severe: slope.....	Severe: slope.....	Severe: slope.....	Severe: slope.....	Severe: slope.....	Severe: slope.....
Rosane: R <sub>t</sub> C.....	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.
Rough broken land: R <sub>u</sub> .	(3).....	(3).....	(3).....	(3).....	(3).....	(3).....
Rough broken land, cold: R <sub>v</sub> .	(3).....	(3).....	(3).....	(3).....	(3).....	(3).....
St. Elmo: SeB, SeD.....	Slight <sup>2</sup> .....	Severe: rapid permeability.	Severe: high content of gravel.	Slight.....	Slight.....	Moderate: high content of gravel.
SeF.....	Moderate where slopes are 9 to 15 percent. Severe where slopes are more than 15 percent.	Severe: rapid permeability.	Severe: high content of gravel; slope.	Moderate: where slopes are 9 to 15 percent. Severe where slopes are more than 15 percent; stones and cobbles; slope.	Moderate where slopes are 9 to 15 percent. Severe where slopes are more than 15 percent.	Severe: slope.....
San Isabel: S <sub>s</sub> C.....	Slight <sup>2</sup> .....	Severe: rapid permeability.	Severe: high content of stones, cobbles, and gravel.	Moderate: high content of stones.	Moderate: high content of stones.	Severe: high content of stones.
Sawatch: S <sub>t</sub> C.....	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.
Shrine: S <sub>u</sub> D.....	Severe: moderately slow permeability.	Moderate where slopes are 3 to 9 percent.	Moderate: clay loam.	Severe: high shrink-swell potential.	Severe: high shrink-swell potential.	Moderate: clay loam.
Slickens: S <sub>w</sub> .....	(3).....	(3).....	(3).....	(3).....	(3).....	(3).....

*properties of the soils—Continued*

Suitability as a source of—				Soil features affecting—		
Road fill	Sand	Gravel	Topsoil	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation
Poor: shallow over bedrock.	Unsuited.....	Unsuited.....	Limited material.	Limited material.	Not applicable....	Not applicable.
Poor: exposed bedrock.	Unsuited.....	Unsuited.....	Poor: exposed bedrock.	Exposed bedrock.	Not applicable....	Not applicable.
Poor: slope.....	Unsuited.....	Unsuited.....	Poor: high content of gravel, cobbles, and stones.	Slope.....	Not applicable....	Not applicable.
Poor: poorly drained.	Poor .....	Good <sup>1</sup> .....	Poor: poorly drained.	High compacted permeability.	Poor outlets; moderately rapid permeability.	Seasonal high water table; low available water capacity; moderately rapid permeability.
( <sup>3</sup> ).....	( <sup>3</sup> ).....	( <sup>3</sup> ).....	( <sup>3</sup> ).....	( <sup>3</sup> ).....	Not applicable....	Not applicable.
( <sup>3</sup> ).....	( <sup>3</sup> ).....	( <sup>3</sup> ).....	( <sup>3</sup> ).....	( <sup>3</sup> ).....	Not applicable....	Not applicable.
Good .....	Poor .....	Good <sup>1</sup> .....	Fair: high content of gravel.	High compacted permeability.	Favorable .....	Low available water capacity; rapid permeability.
Poor: content of stones and cobbles; slope.	Poor .....	Good <sup>1</sup> .....	Poor: slope.....	High compacted permeability.	Not applicable....	Not applicable.
Fair: high content of stones.	Poor .....	Good <sup>1</sup> .....	Poor: high content of stones, gravel, and cobbles.	High compacted permeability.	Not applicable....	Not applicable.
Poor: poorly drained.	Poor .....	Good <sup>1</sup> .....	Poor: poorly drained.	High compacted permeability.	Poor outlets; moderately rapid permeability.	Low available water capacity; moderately rapid permeability.
Poor: high shrink-swell potential.	Unsuited .....	Unsuited .....	Fair: clay loam....	Fair compaction characteristics; low shear strength.	Favorable .....	High available water capacity; moderately slow permeability.
( <sup>3</sup> ).....	Unsuited .....	Unsuited .....	Unsuited .....	( <sup>3</sup> ).....	Not applicable....	Not applicable.

TABLE 5.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitations for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Local roads and streets	Campsites
Stecum..... Mapped only with Rock land.	Severe: 20 to 40 inches deep over bedrock; slopes are 15 to 25 percent	Severe: 20 to 40 inches deep over bedrock.	Severe: 20 to 40 inches deep over bedrock.	Severe: 20 to 40 inches deep over bedrock; slopes are 15 to 25 percent.	Severe: slopes are 15 to 25 percent.	Severe: slope.....
*Tigiwon: TgE..... For Turret part, see Turret series.	Slight where slopes are 3 to 8 percent. <sup>2</sup> Moderate where slopes are 8 to 15 percent. <sup>2</sup> Severe where slopes are more than 15 percent. <sup>2</sup>	Severe: moderately rapid permeability.	Severe: high content of gravel and cobbles.	Slight where slopes are 3 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Slight where slopes are 3 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Severe: high content of gravel and cobbles; slope.
Tomichi: ToE.....	Slight where slopes are 5 to 8 percent. <sup>2</sup> Moderate where slopes are 8 to 15 percent. <sup>2</sup> Severe where slopes are more than 15 percent. <sup>2</sup>	Severe: rapid permeability.	Severe: cut banks cave; slope.	Slight where slopes are 5 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Slight where slopes are 5 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Slight where slopes are 5 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.
Troutville: TrE.	Slight where slopes are 3 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Severe: moderately rapid permeability.	Severe: extremely stony below a depth of 14 inches.	Slight where slopes are 3 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Slight where slopes are 3 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Moderate where slopes are 3 to 15 percent: high content of gravel. Severe where slopes are more than 15 percent.
Turret..... Mapped only with Tigiwon soils.	Slight where slopes are 3 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Moderate where slopes are 3 to 7 percent. Severe where slopes are more than 7 percent.	Severe: high content of stones, gravel, and cobbles.	Slight where slopes are 3 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Slight where slopes are 3 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Moderate where slopes are 3 to 15 percent: high content of gravel and cobbles. Severe where slopes are more than 15 percent.
Wet alluvial land: Wa.	Severe: seasonal high water table; overflow.	Severe: seasonal high water table; overflow.	Severe: seasonal high water table; overflow.	Severe: seasonal high water table; overflow.	Severe: seasonal high water table; overflow.	Severe: poorly drained; overflow.

<sup>1</sup> Good for gravel, however, content of cobbles and stones may limit suitability of the soil.<sup>2</sup> Pollution is a hazard in places because of permeability.<sup>3</sup> Too variable for reliable estimates to be made.



*properties of the soils—Continued*

Suitability as a source of—				Soil features affecting—		
Road fill	Sand	Gravel	Topsoil	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation
Poor: limited material.	Unsuited.....	Unsuited.....	Poor: high content of gravel; steep slopes.	Limited material; medium piping hazard; medium compacted permeability.	Not applicable....	Not applicable.
Slight where slopes are 3 to 15 percent. Moderate where slopes are more than 15 percent.	Poor.....	Good <sup>1</sup> .....	Poor: high content of gravel and cobbles.	High compacted permeability.	Not applicable....	Not applicable.
Good where slopes are 5 to 15 percent. Fair where slopes are more than 15 percent.	Fair.....	Poor.....	Poor: thin surface layer.	High compacted permeability.	Not applicable....	Not applicable.
Good where slopes are 3 to 15 percent. Fair where slopes are 15 to 25 percent. Poor where slopes are more than 25 percent.	Poor.....	Poor.....	Poor: high content of gravel and cobbles.	High compacted permeability; poor compaction characteristics.	Not applicable....	Not applicable.
Good where slopes are 3 to 15 percent. Fair where slopes are 15 to 25 percent.	Poor.....	Unsuited.....	Poor: high content of cobbles and gravel.	Medium piping hazard; poor compaction characteristics.	Not applicable....	Not applicable.
( <sup>3</sup> ).....	( <sup>3</sup> ).....	( <sup>3</sup> ).....	Poorly drained.....	( <sup>3</sup> ).....	Not applicable....	Not applicable.

tion. These factors are climate, living organisms, time, relief, and parent material. All of these factors are highly complex. There are many kinds of climate and many combinations of living organisms. Parent materials vary widely in physical, chemical, and mineralogical properties, and there are great differences in the length of time that these factors have been active.

Although the five factors have been traditionally accepted as those that influence soil development, a sixth factor—man and his activities—must be added to complete the list. Man's activity is all too frequently destructive, but nevertheless he drastically alters the character of the soil by such physical processes as mixing, removal, and fertilization, or he alters the soil's natural environment by controlling water movement or the plant cover.

The history of the development of soil characteristics and the study of the interaction of the formative forces is called soil genesis. The characteristics themselves constitute the soil's morphology. Thus, the color of the soil is one feature of soil morphology. The reason that such a color developed is part of the soil's genesis.

It is impossible precisely to reconstruct the history of a soil's development from the limited data available at any one location. To do so it would be necessary to observe the soil and its environment throughout the entire period of its development—in most cases, several thousand years. Since this is impossible, any reconstruction of the soil's genesis must be based on interpretations. These are drawn from the soil's morphology and our accumulated knowledge of how such morphology could most logically have developed.

The system of soil classification used in the United States is based entirely upon the morphological features of the soil. These are features that can be observed or measured and that can be used to group similar soils or separate those that are dissimilar. The selection of what kinds or magnitudes of properties are to be considered as definitive between soils is guided by our understanding of what is a significant indicator of a major difference in genesis. Thus, the two are closely interrelated and both are essential to a good classification system.

In the following sections a general evaluation of the factors that influence soil development in the Chaffee-Lake Area is attempted, and the manner in which soil morphology has been used to group the soils into the units of classification is outlined.

### **Climate**

The climate of the Chaffee-Lake Area is of the semi-arid, continental type (3), but differences in temperature and precipitation vary widely and covariantly with elevation. Variations in elevation are extreme and occur over relatively short distances. The elevation ranges from about 7,050 feet in the valley areas to more than 12,000 feet on some mountain peaks. Temperatures within the area vary inversely with elevation, growing colder as elevation increases. Yearly precipitation varies directly with elevation and increases as elevation increases. Because of the rapidly changing character of soil climate, generalizations relative to the entire survey area are meaningless; how-

ever, by understanding the trends and something of the magnitude of change in both temperature and precipitation as they relate to elevation, a general evaluation of the climate at any point of interest can be constructed.

The average annual air temperature at the Buena Vista weather station (elevation 8,020 feet) is 44° F., and the average summer soil temperature is about 59°. The average annual air temperature at the Leadville weather station (elevation 10,177 feet) is 36.2°, and the average summer soil temperature is 52°.

For the purpose of evaluating soil climate, soil temperature measurements are more useful than air temperature measurements. Ten sites in the survey area and adjacent areas were measured to determine soil temperature at a depth of 20 inches. At the site of the lowest elevation (7,550 feet), Dominson gravelly sandy loam has, at a depth of 20 inches, an average annual soil temperature of 48.5° and an average summer soil temperature of 62.7°. At the site of the highest elevation (11,325 feet), Bross gravelly sandy loam has, at a depth of 20 inches, an average annual soil temperature of 36° and an average summer soil temperature of 44.5°. This represents a decrease of about 3° in average annual soil temperature and 4.5° in average summer soil temperature for each 1,000 feet rise in elevation.

The 47° average annual soil temperature isotherm falls on north slopes at about 7,500 feet contour and on south slopes at about 8,000 feet contour. The 59° average summer soil temperature isotherm occurs at about 8,500 feet on south slopes and about 8,000 feet on north slopes. In the southernmost parts of the valley, soil temperatures are warmer than 47°, but the area is small and is isolated from areas of similar soil temperatures by abruptly rising mountain ranges. Rather than introduce a group of new mapping units in the survey to accommodate the small acreage of soils having average annual soil temperatures warmer than 47°, they have been included with the colder soils that predominate in the survey area.

Soil temperature has a pronounced influence on the activity of biological, chemical, and physical forces affecting soil development. During periods when the soil temperature is near or below 32°, chemical reactions in the soil are drastically slowed, and mechanical movement and physical weathering because of freezing and thawing are at a maximum. At an elevation of 7,750 feet, the period of time in which the soil temperature is near 32° or below at a depth of 20 inches is about 50 days each year. At an elevation of 9,800 feet, this period is about 120 days, and at 11,325 feet, it is about 140 days.

Biological life, though still active, is drastically slowed when soil temperatures are 41° or lower. At an elevation of 7,750 feet in this area, temperature of the soils of the Dominson series at a depth of 20 inches is more than 41° for about 243 days each year. At 10,000 feet, this figure is about 171 days for the Pierian series, and at 11,325 feet, it is about 99 days for the Bross series.

Precipitation increases with increasing elevation and at the Leadville station (elevation 10,177 feet) the

average annual precipitation is 18.5 inches. Unfortunately, rates of precipitation are not so uniform or so predictable as temperature since they are subject to irregularities of wind current, convection, and other factors of local variation. Although misleading when applied specifically to any one local area, general data indicate an increase in annual precipitation rates of about 4.7 inches for each 1,000 feet increase in elevation.

The effectiveness of precipitation in providing soil moisture is dependent upon many factors other than total amount. At the lower elevations in this area, humidity is low and rainfall intensities are relatively great. These both contribute to soil moisture losses. On the other hand, the soil is frozen for relatively short periods, runoff is relatively low in the winter and spring, and the period of greatest activity of soil-forming processes is much longer than at high elevations. The higher elevations receive more total precipitation, but much of it is snow, spring runoff is high, slopes are very steep, and the soils are cold for long periods of time.

In summary, the climate of the Chaffee-Lake Area relative to soil genesis can best be characterized by its extremes and by its variability. Characterization at any one location is very difficult and dependent upon many local factors. Other than those existing between temperature and annual rates of precipitation relative to change in elevation, reliable trends cannot be established for local areas of the survey.

#### ***Living organisms***

Living organisms that affect soil formation can be divided on the basis of their physical size into macro and micro groups. The macrobiological group includes the visible plants and animals that live in or on the soil. The microbiological group includes the extremely small organisms, mainly bacteria, molds, and fungi, that are visible only with the aid of a microscope. Both groups are extremely important in the development of the soils in the survey area.

That part of the macrobiological group consisting of natural or man-introduced vegetation is most easily observed and most easily understood. The Chaffee-Lake Area is a mixed grass and timbered area that has grasses dominating the valley floors at lowest elevations and stands of timber on the bordering mountain slopes. The present distribution pattern between grass and timber has apparently existed for long enough in this area for the soils to reflect these differences in their morphology.

The grassland soils, such as the Pierian soils, have developed under a type of genesis that centers upon a relatively large annual return of organic matter to the surface soil horizons and its rapid decomposition under well-aerated and alkaline conditions. Under the short-grass vegetation characteristic of the survey area, nearly as much organic matter is returned to the soil by the death of plant roots as is returned by the fall of above-surface plant remains. Consequently, soil horizons enriched by humus may extend to greater depths than would be anticipated from the density and height of the above-ground plant growth.

In the Chaffee-Lake Area, the type of soil genesis prevalent in grassland areas produces a soil that has a solum normally averaging 12 to 24 inches in thickness and that is characterized by a friable, granular, humus-enriched surface horizon of moderately light to moderately dark color. The entire solum generally is neutral to moderately alkaline in reaction and if forming in calcareous parent materials, mature profiles are underlain by distinct horizons of visible secondary carbonate, as in the Manhattan series.

Minor soil differences resulting from differences in the amount of grass are common in most landscapes. In the more steeply sloping areas where runoff is more rapid, there is less available soil moisture and the grass cover is thin. In these areas genetic processes proceed at a slower rate and decomposition of organic matter more nearly equals the annual organic matter returns. In consequence, soil horizons are thinner, are lighter colored, and contain less total organic matter.

The opposite effect is noticeable in parts of the landscape where soil water has accumulated. Here, the solum tends to be thicker, surface horizons are darker, and there is more total organic matter in the soil as seen in the soils of the Ouray series, thick surface variant.

With increasing elevation the natural vegetative pattern changes from dominantly grass to dominantly coniferous forest. The transition does not occur abruptly, and there are broad intermediate areas where grassland and timberland interfinger or where stands of trees are open and grass and shrubs constitute a significant part of the ground cover.

In these transitional areas, soils that have some of the characteristics of both grassland and forested soils are present in some landscapes. These can be areas where the two types of genetic processes themselves are nearly in balance or where they have been alternated over the long genetic history of the soil as the kind of vegetation shifted. Such soils as the Pando soils, which formed under these conditions, generally retain the moderately thick, dark surface horizon of the grassland but have a thin, light-colored, eluvial A2 horizon immediately above the B2t horizon.

At the higher elevations, timber stands are dense and understory grasses and shrubs are sparse. Supplies of soil moisture are more plentiful in these areas, and the soils have a thicker solum than those in the grasslands. Needles, twigs, and bark from conifers make up the bulk of the organic matter falling on the soil. These decompose slowly and favor the more acid types of decomposition.

Such soils as the Leadville soils, which formed under these conditions, are characterized by only a very thin, if any, dark-colored mineral surface horizon, but have a moderately thick, very light colored, eluvial A2 horizon that has lost clay, sesquioxides, and humus. Mature profiles have B2t horizons of silicate clay illuviation. Although they normally are only slightly acid to mildly alkaline in reaction, most of the soils lack horizons of visible calcium carbonate accumulation.

Typically, these kinds of soils have what appears to be a degrading A&B horizon lying between the A2 and B2t horizons. The genesis of this horizon has not been

adequately explained, but the horizon appears to be a part of the B2t horizon that is being degraded and converting to an A2 horizon. In some profiles it consists mostly of material like the B2t horizon with interspersed layers (not tonguing or fingering) of material from the A2 horizon. In other profiles it is mostly material like the A2 horizon but with clayey seams and nodules (lamellae) like the B2t horizon embedded within it.

A small part of the Chaffee-Lake Area is at very high elevations above the timberline. These are grass-land areas, but the grass species are very different from those in the warmer valleys. In these areas soil genesis centers upon the yearly addition of organic matter to the surface soil horizon and its decomposition under acid conditions. Temperatures are very cold, and periods of decomposition are relatively short. The Bross soils of these areas are characterized by a moderately thick, dark-colored, strongly acid, crumb-structured surface horizon that has a very high organic-matter content. This horizon is underlain by a bright-colored B2 horizon in which some iron has accumulated.

The effect of animal life on the soils of the Chaffee-Lake Area is less easily distinguished. This does not imply that it is unimportant, or that it does not exist, but only that it is local or that it is approximately uniform for most soils of the area. Careful examination of the soil in most areas shows some evidence of mechanical mixing by earthworms, ants, or burrowing rodents. In some localities gopher activity has been unusually great, and the soil to a depth of as much as 24 inches has been thoroughly mixed so that only fragments of the original soil horizons remain.

The activity of animal life is widespread throughout the survey area, but its effect is more evident in certain soils. Wet soils show less gopher activity than dry soils. Worms or insects also tend to select soils that have temperatures that are best suited to their habits.

Little is known specifically about the microbiological life in the soils of the survey area. Those organisms best adapted to neutral or mildly alkaline reaction, alternate periods of wetness and dryness, and moderately large seasonal ranges of soil temperature are dominant at the lower elevations. Strains active in a more acid environment, prolonged periods of wetting, and cool soil temperature with relatively narrow seasonal fluctuation are more active at higher elevations.

### Time

If the kind and magnitude of all other forces active in soil formation are equal, the parts of any given landscape that have been subjected to their activity for the longest period of time will have the strongest degree of soil formation. It is difficult, however, to determine the chronological age of a soil, for obviously no such uniformity exists in the soil-forming forces. The degree of horizon development displayed by any one profile may have resulted from differences in the intensity of the other factors rather than age; consequently, degree of development alone is not a reliable criterion.

Unless specific dating can be accomplished by archeological means or by evaluating the decay of radioactive substances, the soil scientist must rely upon geomorphic studies of the landscape to arrive at relative dates for particular landscapes.

In such comparisons care should be exercised in the interpretation of chronological age from the degree of genetic development. Genetically young soils commonly are in deposits of great chronological age where, for example, natural erosion has prevented the development of a mature soil by yearly removal of soil material over the ages. Only the most advanced degrees of development can be considered as being reasonably indicative of relative age.

In the Chaffee-Lake Area the problem is made more difficult by the nature of the terrain. The survey area has a mountain and valley topography where the forces of natural erosion are extensively active. Geologic erosion cycles are of relatively short duration, and land forms shaped by one cycle may be obliterated or badly dissected by subsequent cycles so that the untrained observer cannot readily reconstruct the landscape of any one period in time.

As a result of these difficulties, the influence of time on soil development in the Chaffee-Lake Area is poorly understood. Only a few of the most obvious differences are discussed in the following paragraphs.

*Recent deposits on flood plains.*—These are very youthful deposits. In many places soil material is still being deposited. They vary widely in regard to physical, chemical, and mineralogical properties, and their character is mostly inherited from the parent rocks from which they weathered. They are so young that soils with distinct horizons have not had time to form. The Adilis soils are typical of these young soils.

*Stream terraces and alluvial fans.*—These are remnants of stream terraces or alluvial fans of older age than the present stream flood plains. They cover much of the Arkansas River Valley in the survey area and are a mixed system of pediment surfaces associated with past erosion cycles. Their age in any one landscape may vary appreciably, and no attempt has been made to distinguish between their ages.

In landscapes dominated by these kinds of materials, wide differences in chronological age are represented between deposits at specific locations. In consequence, the precise influence of time in the development of the soil at any specific location is unknown. In general, it can be said that soils forming in these materials have moderate degrees of horizon development, and presumably this is at least in part a result of the age factor. Tigiwon and Blanyon soils are typical of these landscapes.

*Glacial till deposits.*—A few discontinuous, localized bodies of glacial till are in the mountain areas. The till deposits are considered to be of Wisconsin age. Such soils as the Leadville soils, which formed in these deposits, are mainly Cryoboralfs and have well-developed horizons, suggesting moderate intervals of chronological time.

*Residually or locally transported materials weathered from underlying bedrock.*—No attempt is made to fix a chronological age for the soils forming on these

deposits, for presumably they could extend backward in time from recent to that preceding the development of the mountain system. That some of them may be extremely old is suggested by the extraordinary thickness of the solum and individual horizons and, in particular, the thickness and degree of development of some of the horizons of silicate clay accumulation. On the other hand, genetically young soils on these deposits do not necessarily imply youthful chronological age, since geologic removal may have kept pace with genetic development.

### Relief

The shape or contour of any part of a landscape, along with its slope, has a pronounced effect on soil formation, mainly through the physical control such factors exert on water movement, soil temperature, wind movement, and geologic or accelerated erosion.

The effect of slope and contour on the distribution of surface water is easily understood. Since the amount of water entering the soil becomes influential in both kind and degree of soil genesis, any factor that regulates the entry of water into the soil or its movement within the soil becomes equally important.

In parts of the survey area, soil moisture is in short supply for at least part of each growing season. Consequently, the amount of water stored during periods of available moisture becomes very important. Nearly level areas where runoff is minimized, concave areas that tend to collect runoff, or areas lying below parts of landscapes where runoff is high, all have types of relief advantageous to the storage of water and its utilization in soil genetic processes. Soils in such areas tend to have thicker and more strongly developed horizons, to be more strongly leached, and to be darker in color.

Some wearing away of sediment from all parts of each landscape is normal and is commonly referred to as geologic erosion. The intensity of such an erosive process increases as slopes increase or as water is channeled. In consequence, parts of some landscapes have a natural rate of removal that exceeds the rate of soil formation. Under these circumstances mature soils can never form. Such areas are extensive in the Chaffee-Lake Area, where the elevation changes rapidly over short distances.

Land form and, more importantly, direction of slope exert an influence on soil temperature. Slopes facing in the direction of the sun are warmer than those sheltered from the sun's rays during much of the day. This effect is pronounced in the high mountain areas, where solar energy delivered to the soil becomes important in counteracting thermal air currents.

The effect of relief in controlling wind currents is not well understood, and observations generally are applicable only to local conditions. Most noticeable is the effect of relief on the accumulation of winter snow. In some alpine areas, such accumulation may prohibit the growth of native vegetation. In others it may provide supplies of soil moisture sufficiently different to control the kind of vegetation.

### Parent materials

Because the area is mountainous, a wide variety of parent materials occur in the Chaffee-Lake Area. The chemical, physical, and mineralogical characteristics of the parent materials are important in soil genesis.

Some general observations about the characteristics of the parent material in the Chaffee-Lake Area can be made, but the observations made in the subsequent paragraphs are very general in nature and do not adequately characterize the parent materials for any specific soil at any specific point in the landscape.

*Recent flood plain alluvium.*—This consists of recent alluvial deposits on flood plains and low terraces. It varies widely from place to place in color, texture, reaction, and mineralogy, but, what is more important, it displays wide variations in these properties vertically within any one profile. It is this pronounced degree of vertical variability that makes it unique. These alluvial deposits are mapped as Gravelly alluvial land and Wet alluvial land.

*Recent deposits of fans and foot slopes.*—These deposits have most of the variability that characterizes the flood-plain deposits, but the soils are relatively uniform vertically, and their organic-matter content is highest in the surface horizon and decreases uniformly with increasing depth. In the Chaffee-Lake Area, most of these soils are medium textured or moderately coarse textured, calcareous, and 7.5YR or yellower in hue. Rhyolite, andesite, granite, gneiss, schist, and basalt have contributed to this sediment. Costilla soils are an example.

*Glacial till.*—These deposits are in discontinuous bodies, generally on mountain side slopes at higher elevations. They are remnants of till sheets or lateral moraines formed by local valley glaciers and are dominantly moderately fine textured, stony or gravelly, mixed materials originating from the rocks that form the sides and floor of the valleys in which the glacier formed. Generally, these are crystalline igneous or metamorphic rocks, although some admixture of Pennsylvanian sedimentary rocks has occurred. Normally, these deposits are noncalcareous. Troutville and Leadville soils are examples of the glacial-till soils.

*Pleistocene fan and terrace deposits.*—These are deposits formed by coalescing fans and terraces. They are associated with erosion cycles older than the present deposits of streams and foot slopes but are as old or slightly younger than those already described. They are dominantly medium textured to fine textured and derive their general character from the bedrock in their vicinity. Most are calcareous in some part of their profile, but some are not. Rarely are they more than slightly acid. Keeldar soils are an example.

*Residuum from crystalline bedrock.*—These are deposits that have weathered in place or have been only locally transported from exposures of crystalline bedrock. They vary in character, depending upon the character of the parent rock. Generally, they are noncalcareous and neutral to mildly alkaline in reaction, and they have coarse fragments in places.

The material derived from granite tends to have a high content of sand that has more than a normal amount of medium and coarse, angular sand. Local



residents refer to it as gritty sand. Content of fine, angular, granitic gravel is high. The material is neutral in reaction. Stecum soils are an example of soils derived from granite.

Materials weathered from gneiss and schist generally are moderately coarse textured or medium textured and contain a relatively high content of mica. Coarse fragments are most commonly cobblestones and stones. The materials are mostly neutral or mildly alkaline in reaction. Granile soils are an example of soils developed mainly from these materials.

### Classification of the Soils

In the taxonomic system of soil classification now used in the United States, the soils are grouped into various categories on the basis of similarity of morphological character (2, 5, 7). All the soils in any one category have certain morphological characteristics in common that distinguish them from all others. These are called differentiating characteristics.

The soils are classified at several levels, each succeeding level being more detailed than the previous one. Thus the series level, which is the most detailed level of generalization, uses many soil properties as differentiating criteria, whereas the orders, which are the least detailed, use comparatively few and broad differences.

The soil classification system provides a means for discussing, studying, and using soil survey information for a variety of purposes and for a variety of intensities. For the most detailed use of soil information, the soil series is the most efficient taxonomic unit to use. For less detailed purposes the family or subgroup is adequate and easily understood. For still more general uses of soil information, such as comparison of these soils to those in other parts of the United States or the world, the great group, subgroup, or order may be the best level classification to use. The classification of the soils of the Chaffee-Lake Area is given in table 6.

*Orders, suborders, great groups:* These subdivisions of the taxonomic system group soils on the basis of relatively broad sets of differentiating criteria designed principally to bring together soils that are similar in horizonation, genesis, and environment. They are most useful in quickly showing general soil differences within the survey area, in understanding the basic genetic processes active in the area, and in comparing the overall soil pattern of the area with others of the world. Their value for designing specific management practices is extremely limited, but they are useful for broad county, State, or national planning purposes.

In the following paragraphs, each of the five orders represented in the Chaffee-Lake Area and the suborders and great group within each order are briefly discussed.

TABLE 6.—*Classification of soils*

Series	Family	Subgroup	Order
Adilis	Sandy-skeletal, mixed, frigid	Ustic Torriorthents	Entisols.
Antero	Coarse-loamy, mixed (calcareous), frigid	Typic Haplaquepts	Inceptisols.
Blanyon	Fine, montmorillonitic	Borollic Vertic Haplargids	Aridisols.
Bross	Loamy-skeletal, mixed	Pergelic Cryumbrepts	Inceptisols.
Cabin	Fine-loamy over sandy or sandy-skeletal, mixed	Argic Cryoborolls	Mollisols.
Chaffee	Coarse-loamy, mixed, frigid	Cumulic Haplaquolls	Mollisols.
Collegiate	Coarse-loamy over sandy or sandy-skeletal, mixed, frigid	Cumulic Haplaquolls	Mollisols.
Costilla <sup>1</sup>	Mixed, frigid	Typic Torripsamments	Entisols.
Cotopaxi	Mixed, frigid	Typic Torripsamments	Entisols.
Dominson	Sandy-skeletal, mixed	Torriorthentic Haploborolls	Mollisols.
Gas Creek	Sandy-skeletal, mixed, frigid	Typic Haplaquolls	Mollisols.
Granile	Loamy-skeletal, mixed	Typic Cryoborolls	Alfisols.
Grantsdale <sup>2</sup>	Fine-loamy over sandy or sandy-skeletal, mixed	Typic Haploborolls	Mollisols.
Hawksell	Coarse-loamy, mixed (calcareous), frigid	Ustic Torriorthents	Entisols.
Keeldar	Coarse-loamy, mixed	Aridic Calciborolls	Mollisols.
Leadville	Loamy-skeletal, mixed	Typic Cryoborolls	Alfisols.
Manhattan	Coarse-loamy, mixed	Typic Calciborolls	Mollisols.
Newfork	Sandy-skeletal, mixed	Typic Cryaquolls	Mollisols.
Ouray	Sandy, mixed	Torriorthentic Haploborolls	Mollisols.
Ouray, thick surface variant	Coarse-loamy, mixed	Pachic Haploborolls	Mollisols.
Pando	Loamy-skeletal, mixed	Borollic Cryoborolls	Mollisols.
Pierian	Sandy-skeletal, mixed	Typic Cryoborolls	Mollisols.
Poncha	Sandy-skeletal, mixed	Calcic Cryoborolls	Mollisols.
Rosane	Coarse-loamy over sandy or sandy-skeletal, mixed	Typic Cryaquolls	Mollisols.
St. Elmo	Sandy-skeletal, mixed	Aridic Calciborolls	Mollisols.
San Isabel	Loamy-skeletal, mixed	Aridic Argiborolls	Mollisols.
Sawatch	Coarse-loamy over sandy or sandy-skeletal, mixed, frigid	Histic Haplaquolls	Mollisols.
Shrine	Fine-loamy, mixed	Torriorthentic Haploborolls	Mollisols.
Stecum	Sandy-skeletal, mixed	Typic Cryorthents	Entisols.
Tigiwon	Fine-loamy over sandy or sandy-skeletal, mixed	Borollic Haplargids	Aridisols.
Tomichi	Sandy, mixed	Typic Cryoborolls	Mollisols.
Troutville	Loamy-skeletal, mixed	Psammentic Cryoborolls	Alfisols.
Turret	Fine-loamy, mixed	Aridic Argiborolls	Mollisols.

<sup>1</sup> Costilla soils in this survey area are finer textured than normal for the series and are taxadjuncts.

<sup>2</sup> Grantsdale soils in this survey area are drier than normal for the series and are taxadjuncts.

*Entisols* are soils that are so youthful that they have not had time to develop distinct genetic horizonation, other than a slight darkening of the surface horizon or inconsistent accumulation of soluble salt. There may be considerable physical or chemical difference between strata of these soils, but these differences are not the result of soil development but are characteristics of the parent material as it was deposited or as it weathered.

In the Chaffee-Lake Area, the Entisols are divided into the suborders Psamments and Orthents. The Psamments are a grouping of soils that are uniformly sandy. Entisols having more than 35 percent coarse fragments or matrix materials that have textures finer than loamy fine sand are excluded from this suborder.

The Orthents are well-drained soils that have textures finer than loamy fine sand, or if textures are loamy fine sand or coarser, they contain more than 35 percent coarse fragments. They lack diagnostic horizonation except for an ochric epipedon and have an organic-matter distribution pattern that is maximum in the surface horizon and decreases regularly with increasing depth.

At the great group level, the Psamments are represented only by the Torripsamments. These are the dry Psamments in arid or semiarid regions.

The Orthents of the area are subdivided into the great groups Cryorthents and Torriorthents. The Cryorthents are cold soils belonging to the Orthent suborder. They have an average annual soil temperature of less than 47° F. and an average summer soil temperature of less than 59°. The Torriorthents are dry soils in arid and semiarid regions. They have an average annual soil temperature that is colder than 47°, but the average summer soil temperature is warmer than 59°.

*Inceptisols* are youthful soils that have more advanced horizon development than the Entisols. They have a B2 horizon showing evidence of alteration of parent material by pedogenic processes, but lack distinct and continuous illuvial horizons of clay, iron, aluminum, or organic carbon. Some of the soils in this order have a thick, dark-colored A1 horizon that is less than 50 percent base saturated. Others have a light-colored A1 horizon.

The Inceptisols of this area are divided into the suborders Aquepts and Umbrepts. The Aquepts are light-colored soils that formed under the influence of a high water table. They have a B2 horizon of low base chroma that is mottled with segregated iron. The Umbrepts are soils that have a thick, dark-colored A horizon and a base saturation of less than 50 percent.

At the great group level, the only representative of the Aquepts found in the Chaffee-Lake Area is the great group Haplaquepts. These are Aquepts that have an annual summer soil temperature of more than 55°, less than 15 percent sodium saturation, and a light-colored surface horizon.

The Cryumbrepts are the only representatives of the Umbrepts found in the Area. These Umbrepts are at high elevations where the average summer soil temperature is less than 59°.

*Aridisols* are light-colored soils of arid and semiarid regions that have been in place long enough to develop distinct genetic horizonation in harmony with the forces of their environment. Although they primarily are grassland soils, the decomposition of organic matter has more or less equalized the yearly additions to the soil. In consequence, they have been unable to develop the dark surface horizon that characterizes the Mollisols. These soils may be associated with the same landscape as the Mollisols, but they generally occupy those parts of the landscape where runoff or soil texture has proportionately restricted the entry of moisture into the soil.

The Argids are the only suborder of Aridisols represented. These are the Aridisols that have developed distinct and continuous horizons of silicate clay accumulation.

The great group Haplargids is the only representative of the Argids in the survey area. These soils have an illuvial B2t horizon of silicate clay that is not saturated with sodium and has a gradual increase in clay content at its upper boundary.

*Mollisols* are soils of the subhumid regions that are characterized by a thick, dark-colored, friable, base-enriched surface horizon in which a plentiful supply of organic matter has accumulated. Soil scientists refer to this surface horizon as a mollic epipedon. This accumulation is the result of the decomposition of a relatively large yearly return of organic plant material to the surface horizon, either by the fall of plant remains or by the decay of plant root systems in the presence of a predominance of bivalent cations.

The Aquolls and Borolls are the only suborders of the Mollisol order represented in the survey area. The Aquolls are poorly drained, and they have a B2 horizon that formed under a high water table. They are similar to the Aquepts previously described but differ in having a mollic epipedon. The Borolls are cold soils in which the average annual soil temperature is less than 47°.

The Aquolls are represented by the great groups Haplaquolls and Cryaquolls. The Haplaquolls lack horizons of silicate clay accumulation and have an average summer soil temperature warmer than 55°. The Cryaquolls are the Aquolls of cold areas. They are at relatively high elevations and have an average summer soil temperature of less than 55°.

The suborder Borolls has been divided into the great groups of Cryoborolls, Haploborolls, Argiborolls, and Calciborolls. The Cryoborolls are Borolls of high elevation and very cold temperature. Their average soil temperature is less than 59°.

The Haploborolls have average soil temperatures warmer than the Cryoborolls. They lack horizons of silicate clay accumulation, and they do not have horizons of strong accumulation of secondary calcium carbonate.

The Argiborolls have continuous horizons of silicate clay illuviation, and they do not have horizons of strong accumulation of secondary calcium carbonate.

The Calciborolls lack horizons of silicate clay accumulation, but they have strongly developed horizons of secondary calcium carbonate accumulation.

*Alfisols* are light-colored soils of subhumid areas that have genetic horizons of silicate clay accumulation and are more than 60 percent base saturated. In the Chaffee-Lake Area, they are represented by the timbered soils at high elevations.

The Boralfs are the only suborder of Alfisols in the survey area, and the Cryoboralfs are the only representative of the Boralf suborder. These soils are at high elevations. They have average summer soil temperatures either of less than 59° if the timber stand is open and the organic surface horizon is thin, or less than 47° if the timber stand is dense and the organic surface horizon is thick.

*Subgroups, families, series.*—These are the more detailed categories of the taxonomic classification system. The series is the most detailed. Differences between units at this level are drawn on such detailed individual soil properties as color, structure, texture, reaction, and the consistence of individual soil horizons. Of these three categories, the series provides the most information about the soil at any specific location and has the greatest use for determining soil use or management practices.

The family is a grouping of soil series based primarily on similarities of physical, mineralogical, chemical, and environmental properties. Families are less detailed than the series themselves. Nevertheless, they have considerable value for grouping soils of similar character. They can be utilized effectively for planning purposes when any one factor, or any combination of factors, used to define the families is of prime importance to the soil uses being considered.

The subgroup is a grouping of soil families. One subgroup represents the central (typic) segment of the great group. Other subgroups, called integrades, have one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soil properties intergrade outside the range of any other great group, suborder, or order.

## General Nature of the Survey Area

This section discusses history, climate, physiography, and geology, all of which have been important in the formation and use of the soils.

## History

The first settlement in the valley was made in 1861. In 1779, Juan Bautista de Anza, Governor at Santa Fe, led an expedition of 645 men up the San Luis Valley over what is now called Poncha Pass, to where Salida now stands.

In 1859 and 1860, many prospectors for gold came to the mountains. Some of these prospectors discovered placers in the northern part of what is now Chaffee County.

The first placer was discovered 4 miles below Granite early in the spring of 1860. The first prospecting for minerals in the vicinity of the South Arkansas River was in 1863, when some gold was found on Mount Shavano. By fall, there were approximately 1,000

people prospecting in or near there. No paying mines were discovered, and the camp was abandoned.

Many of the prospectors were formerly farmers. After they became disappointed in their mining ventures, they began looking for homesteads. The first rancher in the upper Arkansas River Valley settled in 1863 in what is now Riverside. He packed in seed potatoes from Castle Rock to plant his first crop, which he sold in the mining camps at 50 cents per pound. That same year the first settler located on the South Arkansas River. He homesteaded 160 acres and took the first water from the river for irrigation. He also brought in the first cattle.

By 1870, a number of ranches were being operated, and there were a number of herds of cattle in the valley. Mining was established and many prospectors were in the mountains.

## Climate<sup>6</sup>

The year-round climate in the Chaffee-Lake survey area is considered to be normal for the mountainous part of Colorado. Farming is limited by a deficiency of water and a relatively short frost-free season. There are three official weather reporting stations in the survey area. These stations are at Salida and Buena Vista in Chaffee County and at Leadville in Lake County.

The climatic features at Salida are generally representative for the southern part of the survey area and, to a limited extent, for the northern part of the area.

The records from the Salida station (elevation 7,060 feet) show that the average annual precipitation is 10.87 inches. The average frost-free season is 107 days, and the average summer temperature is 62.6°. The average annual temperature is 46.5°. The months of highest rainfall are July and August, and the months of lowest precipitation are December and January.

The Buena Vista station (elevation 7,954 feet) reports an average summer temperature of 58°. The average annual temperature is 44°. The average frost-free season at Buena Vista is 95 days. The precipitation pattern is similar to that of the Salida area. Average annual precipitation is 9.28 inches.

The Leadville station in Lake County (elevation 10,177 feet) records an average annual temperature of 36.2°. The kinds of crops that can be raised are limited because the average minimum temperature through the summer is only 35.7°. The average frost-free season is 79 days. Average annual precipitation is 18.48 inches.

Snowfall in the mountainous part of the survey area varies considerably from year to year, but it ranges in depth from 8 to 15 feet. Snowfall furnishes the water for irrigation in the area.

Because of climatic conditions, a large part of the survey area considered to be irrigated land is in meadows, and some is in small grains, native hay, and alfalfa. The area is considered better adapted to live-

<sup>6</sup> By J. W. BERRY, State climatologist, National Weather Service, U.S. Department of Commerce.

stock production than to farming. There is no dryland farming within the survey area.

Temperature and precipitation data are given in table 7. Probabilities of the last freezing temperatures in spring and the first in fall are given in table 8.

### Physiography

The upper Arkansas River Valley in Chaffee and Lake Counties occupies a long, narrow, structural trough that was formed mainly by faulting. The chief topographic features of this area are the two great

parallel north-south mountain ranges that border the valley, the Sawatch Range on the west and the Mosquito Range on the east. Toward the south, the Mosquito Range merges with a low range of hills. Most of the larger tributaries of the Arkansas River originate in the Sawatch Range, and most of the survey area consists of the open valleys and broad sloping uplands lying along the lower reaches of these tributaries.

The structural trough occupied by the upper Arkansas River Valley, between Leadville and Salida, consists of two basins developed in soft sedimentary for-

TABLE 7.—*Temperature and precipitation*

[All data from Salida, Chaffee County, Colorado, elevation 7,060 feet]

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	Two years in 10 will have at least 4 days with—		Average monthly total	One year in 10 will have—		Days with snow cover of 1 inch or more	Average depth of snow on days with snow cover of 1 inch or more
			Maximum temperature equal to or higher than—	Minimum temperature equal to or lower than—		Less than—	More than—		
	°F	°F	°F	°F	Inches	Inches	Inches	Number	Inches
January.....	43	12	56	— 6	0.41	0.1	0.9	7	3
February.....	47	15	61	— 1	.53	.1	1.1	5	4
March.....	53	20	66	7	.80	.2	1.5	3	3
April.....	62	28	74	18	1.32	.3	2.8	2	5
May.....	70	36	80	28	1.34	.4	2.8	( <sup>1</sup> )	3
June.....	80	42	88	36	.77	.1	1.6		
July.....	85	47	90	42	1.48	.5	3.4		
August.....	83	46	88	39	1.47	.6	2.4		
September.....	77	38	85	30	.77	.2	1.8	( <sup>1</sup> )	6
October.....	67	29	77	20	1.00	.1	2.9	( <sup>1</sup> )	2
November.....	53	19	66	6	.55	.1	1.8	6	6
December.....	46	14	57	0	.43	.1	1.2	5	5
Year.....	64	29	91	— 17	10.87	7.2	16.8	28	4

<sup>1</sup> Less than one-half day.

<sup>2</sup> Average annual highest temperature.

<sup>3</sup> Average annual lowest temperature.

TABLE 8.—*Probabilities of last freezing temperatures in spring and first in fall*

[All data from Salida, Chaffee County, Colorado]

Probability	Dates for given probability and temperature				
	16° F or lower	20° F or lower	24° F or lower	28° F or lower	32° F or lower
Spring:					
1 year in 10 later than.....	April 19	May 1	May 13	May 28	June 16
2 years in 10 later than.....	April 14	April 26	May 8	May 23	June 11
5 years in 10 later than.....	April 4	April 16	April 29	May 13	June 1
Fall:					
1 year in 10 earlier than.....	October 16	October 7	September 28	September 10	August 9
2 years in 10 earlier than.....	October 21	October 12	October 3	September 16	September 4
5 years in 10 earlier than.....	October 31	October 21	October 12	September 25	September 13

mations and separated by a stretch of narrow canyon where the river is entrenched in resistant rock. The first basin, in which Leadville and Malta are located, is about 15 miles long by 12 miles wide and extends to a point about 5 miles north of the station of Granite. Within this basin are high stony plains or terraces that rise toward the bordering mountains, where they grade into rock shoulders or pediments thinly mantled with stones.

From the south end of the Leadville basin to a point about 8 miles below the station of Granite, the Arkansas River lies in a narrow canyon cut mainly in crystalline rock. At some places the western canyon wall is rugged moraine deposited by glaciers from the Sawatch Mountains. This canyon opens into a basin, about 37 miles long and 10 miles wide, that contains the towns of Buena Vista and Salida. The western part of this basin consists of a series of broad upland surfaces that rise toward the Sawatch Range. Several levels of stream terraces lie along the Arkansas River and its major tributaries.

The relatively small part of the survey area lying in the steep mountainous country east of Leadville is characterized by erosional features of alpine glaciers, such as U-shaped valleys, criques, serrated ridges, and lake basins.

## Geology

The complexity of the geology of the Chaffee-Lake Area is typical of most mountainous areas. Many types and forms of geological outcrop or parent rock can be observed in this rough, broken topography.

Rocks of Precambrian age make up the largest part of the bedrock area in the upper Arkansas River drainage basin. Much of the Sawatch Range is formed from these rocks, as is also the area lying along the eastern side of the Arkansas River in Chaffee County. The Precambrian rocks in Chaffee and Lake Counties are composed of a metamorphic complex of schist and gneiss that has been extensively intruded by granite, aplite, and pegmatite and, to a lesser degree, by quartz diorite. These rocks vary widely in composition, but most are high in silica (persilicic).

Rocks of Paleozoic age crop out extensively in the Mosquito Range and in small areas in southwestern Chaffee County. In most places the geological outcropping consists mainly of medium-grained quartzite and some dolomite and limestone.

Tertiary intrusive rocks, including several varieties of porphyry, mostly of the quartz-monzonitic composition, are in the northeastern part of the survey area.

In eastern Chaffee County, east of the Arkansas River, there are several scattered exposures of rhyolitic and trachytic flows, of which the best known is Ruby Mountain.

The Leadville and Salida basin of the upper Arkansas River Valley contains thick deposits of poorly consolidated sediment of the Tertiary Period. This sediment is of Pliocene age and is called the Dry Union Formation.

The Dry Union Formation occupies a large part of the survey area from the vicinity of Leadville to Salida.

Its susceptibility to erosion is a major factor in the physiographic development of the upper Arkansas River Valley. The Dry Union Formation generally is mantled with Quaternary surficial deposits, but north of Poncha Springs it is widely exposed in an area of badland topography. The gravel and sand are locally arkosic and cross bedded. The sediment has been faulted to an extent and dips in various directions, generally at low angles.

The detrital sediment that makes up the Dry Union Formation in the Leadville area chiefly is silt and sand, apparently deposited in alluvial fans. Pebbles and cobblestones are scattered throughout the formation but are most abundant near the mountain slopes.

The Dry Union Formation appears to have been derived from mountains somewhat lower than those of today and deposited in broad playa basins, in an arid and possibly cold climate. Leached zones and caliche-cemented zones probably formed during episodes of subaerial weathering while the sediment accumulated.

Deposits of Quaternary age, which cover the largest part of the Chaffee-Lake Area, consist primarily of unconsolidated materials derived from weathering of older formations and transported and redeposited by colluvial-alluvial, glacial, or eolian processes. These deposits are composed of varying proportions of clay, silt, sand, gravel, cobblestones, and stones.

Any attempt to classify Quaternary surficial deposits should take into account the amount of sorting or mixing that materials undergo during transport as well as the nature of the transporting agency. The four main kinds of transported and deposited materials are: (1) *colluvial* materials that are moved by gravity with some influence from ice or water; (2) *glacial* materials that are transported mainly by ice; (3) *alluvial* materials that are transported mainly by running water; and (4) *eolian* materials that are carried by wind.

Deposits transported by colluvial-alluvial action show little or no sorting and generally consist of materials derived from a single source. Glacial deposits show little or no sorting but commonly contain materials derived from several sources, although in many places materials from a single rock type are dominant. Alluvial deposits are characterized by a sorting of materials by particle size. The degree of sorting varies widely depending largely on stream size. Alluvial deposits commonly contain materials derived from several types of rock. Eolian deposits are characterized by a high degree of sorting, in which either silt or sand is dominant, and are consequently also fairly homogeneous in mineral composition in any one area.

Alluvium is material deposited permanently or in transit by streams. It consists of deposits containing boulders, cobblestones, gravel, sand, silt, and clay and all variations and mixtures of these.

Glacial deposits in high mountain valleys generally take the form of ridgelike embankments that have undulating surfaces and are called moraines. Moraines consist largely of ice-deposited material or till, but a certain amount of water-laid material may also be present. Generally, the most conspicuous of the morainal deposits are end or terminal moraines, which



are those that formed at the lower end of a glacier at its maximum extent. Lateral moraines are those that form along the sides of an ice stream, chiefly from materials that are contributed from the valley sides.

Deposits that can be definitely classed as eolian are not extensive in the Chaffee-Lake Area and occur only locally where conditions have been favorable for deeper accumulations of windblown material. However, it is probably also true that eolian deposits are among the most widespread of surficial materials, in that small amounts of windblown sand, silt, or clay have been carried at times to most parts of the area and intermixed to varying degrees with the surface materials in the other types of deposits.

## Literature Cited

- (1) AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS.  
1961. STANDARD SPECIFICATIONS FOR HIGHWAY MATERIALS AND METHODS OF SAMPLING AND TESTING. Ed. 8, 2 v., illus.
  - (2) BALDWIN, MARK, KELLOGG, CHARLES E., and THORP, JAMES.  
1938. SOIL CLASSIFICATION. U.S. Dept. Agr. Ybk., pp. 970-1001, illus.
  - (3) COLORADO STATE PLANNING DIVISION.  
1959-61. climatological data. Colorado Ybk., pp. 413-426.
  - (4) PORTLAND CEMENT ASSOCIATION.  
1956. PCA SOIL PRIMER. 86 pp., illus. Chicago, Ill.
  - (5) THORP, JAMES and SMITH, GUY D.  
1949. HIGHER CATEGORIES OF SOIL CLASSIFICATION: ORDER, SUBORDER, AND GREAT SOIL GROUPS. Soil Sci. 67: 117-126.
  - (6) UNITED STATES DEPARTMENT OF AGRICULTURE.  
1951. SOIL SURVEY MANUAL. U.S. Dept. Agr. Handbook No. 18, 503 pp., illus.
  - (7) ————  
1960. SOIL CLASSIFICATION, A COMPREHENSIVE SYSTEM, 7TH APPROXIMATION. 265 pp., illus. [Supplements issued in March 1967 and September 1968]
  - (8) UNITED STATES DEPARTMENT OF DEFENSE.  
1968. UNIFIED SOIL CLASSIFICATION SYSTEM FOR ROADS, AIRFIELDS, EMBANKMENTS AND FOUNDATIONS. MIL-STD-619B, 30 pp., illus.
- Plastic.*—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.
- Sticky.*—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.
- Hard.*—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.
- Soft.*—When dry, breaks into powder or individual grains under very slight pressure.
- Cemented.*—Hard and brittle; little affected by moistening.
- Drainage class (natural).** Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.
- Excessively drained* soils are commonly very porous and rapidly permeable and have a low water-holding capacity.
- Somewhat excessively drained* soils are also very permeable and are free from mottling throughout their profile.
- Well-drained* soils are nearly free from mottling and are commonly of intermediate texture.
- Moderately well drained* soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and have mottling in the lower B and the C horizons.
- Somewhat poorly drained* soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.
- Poorly drained* soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.
- Very poorly drained* soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.
- Eolian soil material.** Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.
- Erosion.** The wearing away of the land surface by wind (sand-blast), running water, and other geological agents.
- Fertility, soil.** The quality of a soil that enables it to provide compounds, in adequate amounts and in proper balance, for the growth of specified plants, when other growth factors such as light, moisture, temperature, and the physical condition of the soil are favorable.
- First bottom.** The normal flood plain of a stream, subject to frequent or occasional flooding; land along a stream that is subject to overflow.
- Foot slopes.** The terminal part of a long slope. Generally, not as steep as the slope above.
- Glacial deposits.** Materials moved and redeposited by glacial processes; generally coarse textured, loose, and porous. They consist mainly of a mixture of sand, gravel, cobbles, and boulders.
- Horizon, soil.** A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:
- O horizon.*—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.
- A horizon.*—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).
- B horizon.*—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of

## Glossary

- Alluvium.** Soil material, such as sand, silt, or clay, that has been deposited on land by streams.
- Aspect (forestry).** The direction toward which a slope faces. Synonym: exposure.
- Calcareous soil.** A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.
- Colluvium.** Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.
- Consistence, soil.** The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—
- Loose.*—Noncoherent when dry or moist; does not hold together in a mass.
- Friable.*—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.
- Firm.*—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

**C horizon.**—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

**R layer.**—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

**Internal soil drainage.** The downward movement of water through the soil profile. The rate of movement is determined by the texture, structure, and other characteristics of the soil profile and underlying layers and by the depth of the water table, either permanent or perched. Relative terms for expressing internal drainage are *none*, *very slow*, *slow*, *medium*, *rapid*, and *very rapid*.

**Irrigation head.** The total amount of water released at the upper end of a field.

**Land leveling.** The reshaping of the ground surface to make for a more uniform application of irrigation water.

**Leaching.** The removal of soluble materials from soils or other material by percolating water.

**Mottling, soil.** Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance—*few*, *common*, and *many*; size—*fine*, *medium*, and *coarse*; and contrast—*faint*, *distinct*, and *prominent*. The size measurements are these: *fine*, less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium*, ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse*, more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

**Nutrient, plant.** Any element taken in by a plant, essential to its growth and used by it in the production of food and tissue. Nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, zinc, and perhaps other elements obtained from the soil and carbon, hydrogen, and oxygen obtained largely from the air and water, are plant nutrients.

**Ped.** An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

**Permeability.** The quality that enables the soil to transmit water or air. Terms used to describe permeability are as follows: *very slow*, *slow*, *moderately slow*, *moderate*, *moderately rapid*, *rapid*, and *very rapid*.

**Reaction, soil.** The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

pH		pH	
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

**Relief.** The elevations or inequalities of a land surface, considered collectively.

**Soil.** A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

**Soil temperature.** Temperature of soil at a depth of 20 inches. Average annual temperature is the average for 12 months. Average summer temperature is the average for June, July, and August.

**Structure, soil.** The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

**Subsoil.** Technically, the B horizon; roughly, the part of the solum below plow depth.

**Substratum.** Technically, the part of the soil below the solum.

**Subsurface layer.** The layer beneath the surface soil that occupies the same position in a weakly developed soil that the subsoil occupies in a well-developed soil.

**Surface soil.** The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

**Taxadjunct.** Soils that are unclassified at the series level but allowed to go under the name of a defined series. They are so like the soils of the defined series in morphology, composition, and behavior that little or nothing is gained by adding a new series.

**Texture, soil.** The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand*, *loamy sand*, *sandy loam*, *loam*, *silt loam*, *silt*, *sandy clay loam*, *silty clay loam*, *sandy clay*, *silty clay*, and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

**Variant, soil.** A soil having properties sufficiently different from those of other known soils to suggest establishing a new soil series, but a soil of such limited known area that creation of a new series is not believed to be justified.

**Water spreading.** Diverting runoff from a gully or watercourse onto gently sloping, absorptive land to conserve waste water or increase plant growth, to reduce flood peaks, or to replenish ground-water supplies.

For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. In referring to a capability unit or a range site, read the introduction to the section it is in for general information about its management. For information on the use and management of the soils for range, see the section beginning on page 40. For information on the use and management of soils for woodland, see the section beginning on page 43. Other information is given as follows:

Acres and extent, table 1, page 9.  
Predicted yields, table 2, page 38.

Wildlife, table 3, page 46.  
Engineering, tables 4 and 5, pages 48 and 56.

Map symbol	Mapping unit	Page	Capability unit		Range site	
			Irrigated	Nonirrigated	Name	
AdC	Adilis loam, 1 to 5 percent slopes-----	9	IVw-1	36	-----	-----
AnB	Antero sandy loam, 1 to 3 percent slopes-----	10	IVw-1	36	-----	-----
Ba	Badland-----	10	-----	-----	VIIIe-1	40
BlB	Blanyon clay loam, 1 to 3 percent slopes-----	11	IVe-2	36	VIIe-2	38
BrF	Bross gravelly sandy loam, 9 to 45 percent slopes-----	11	-----	-----	VIIe-2	39
CaE	Cabin gravelly sandy loam, 9 to 25 percent slopes-----	12	-----	-----	VIIe-3	38
ChB	Chaffee loam, 1 to 3 percent slopes-----	12	IVw-1	36	-----	-----
ClB	Collegiate loam, 1 to 3 percent slopes-----	13	IVw-1	36	-----	-----
CoD	Costilla gravelly sandy loam, 3 to 9 percent slopes-----	13	VIIe-1	37	VIIe-3	38
CtD	Cotopaxi loamy sand, 3 to 9 percent slopes----	14	VIIe-1	37	VIIe-3	38
DoD	Dominson gravelly sandy loam, 1 to 9 percent slopes-----	14	VIIe-1	37	VIIe-3	38
DoF	Dominson gravelly sandy loam, 9 to 45 percent slopes 1/-----	14	-----	-----	VIIe-1	39
GcB	Gas Creek gravelly sandy loam, 1 to 3 percent slopes-----	15	IVw-1	36	-----	-----
GrE	Granite gravelly sandy loam, 3 to 35 percent slopes 2/-----	16	-----	-----	VIIe-4	39
GsD	Grantsdale fine sandy loam, 3 to 9 percent slopes-----	17	IVe-3	36	VIIe-3	38
Gv	Gravelly alluvial land-----	17	-----	-----	VIIIIs-1	40
HaD	Hawksell sandy loam, 5 to 9 percent slopes----	17	IVe-3	36	VIIe-3	38
KeC	Keeldar gravelly sandy loam, 1 to 5 percent slopes-----	18	IVe-3	36	VIIe-3	38
LeE	Leadville sandy loam, 3 to 35 percent slopes 3/-----	19	-----	-----	VIIe-4	39
MaB	Manhattan sandy loam, 1 to 3 percent slopes---	20	IVe-3	36	VIIe-3	38
MaD	Manhattan sandy loam, 3 to 9 percent slopes---	20	IVe-3	36	VIIe-3	38
Mh	Marsh-----	20	-----	-----	VIIIw-1	40
Mp	Mine pits and dumps-----	20	-----	-----	VIIIIs-1	40
NfB	Newfork gravelly sandy loam, 1 to 3 percent slopes-----	21	Vw-1	37	-----	-----
OrC	Ouray sandy loam, 1 to 5 percent slopes-----	21	IVe-3	36	VIIe-3	38
OuB	Ouray gravelly loam, thick surface variant, 1 to 3 percent slopes-----	22	IVe-3	36	VIIe-3	38
PaD	Pando gravelly sandy loam, 3 to 9 percent slopes 2/-----	22	VIIe-1	37	VIIe-4	39
Pe	Peat-----	23	-----	-----	VIIIw-1	40
PgD	Pierian gravelly sandy loam, 3 to 9 percent slopes-----	23	-----	-----	VIIe-3	38
PlF	Pierian soils, 20 to 45 percent slopes-----	23	-----	-----	VIIe-1	39
Pn	Placer diggings and tailings-----	23	-----	-----	VIIIIs-1	40
PoC	Poncha gravelly sandy loam, 1 to 5 percent slopes-----	24	VIIe-1	37	VIIe-3	38
RcF	Rock land, 15 to 60 percent slopes 1/-----	24	-----	-----	VIIIIs-1	40

Map symbol	Mapping unit	Page	Capability unit				Name site
			Irrigated		Nonirrigated		
			Symbol	Page	Symbol	Page	Name
RgE	Rock land-Gravelly land complex, 3 to 35 percent slopes 1/-----	24	-----	----	VIIIIs-1	40	-----
	Gravelly land part-----	----	-----	----	-----	----	Mountain Loam
	Rock land part-----	----	-----	----	-----	----	-----
RkF	Rock land-Stecum complex, 15 to 60 percent slopes 1/-----	24	-----	----	VIIIIs-1	40	-----
Ro	Rock outcrop-----	24	-----	----	VIIIIs-1	40	-----
Rs	Rock slides-----	25	-----	----	VIIIIs-1	40	-----
RtC	Rosane loam, 1 to 5 percent slopes-----	26	Vw-1	37	-----	----	-----
Ru	Rough broken land 1/-----	26	-----	----	VIIe-1	39	-----
Rv	Rough broken land, cold-----	26	-----	----	VIIe-1	39	-----
SeB	St. Elmo gravelly sandy loam, 1 to 3 percent slopes-----	27	IVs-1	36	VIe-3	38	Dry Mountain Outwash
SeD	St. Elmo gravelly sandy loam, 3 to 9 percent slopes-----	27	VIe-1	37	VIe-3	38	Dry Mountain Outwash
SeF	St. Elmo gravelly sandy loam, 9 to 45 percent slopes 1/-----	27	-----	----	VIIe-1	39	Dry Mountain Outwash
SsC	San Isabel stony sandy loam, 1 to 5 percent slopes 1/-----	28	-----	----	VIIIs-1	39	Boulder Flats
StC	Sawatch sandy loam, 1 to 5 percent slopes-----	28	IVw-1	36	-----	----	-----
SuD	Shrine clay loam, 3 to 9 percent slopes-----	29	IVe-1	35	VIe-2	38	-----
Sw	Slickens-----	29	-----	----	VIIIIs-1	40	-----
TgE	Tigiwon-Turret cobbly sandy loams, 3 to 25 percent slopes 1/-----	30	-----	----	VIIe-1	39	-----
ToE	Tomichi sandy loam, 5 to 25 percent slopes-----	31	-----	----	VIe-5	39	Subalpine Loam
TrE	Troutville gravelly sandy loam, 3 to 35 percent slopes 3/-----	32	-----	----	VIe-4	39	-----
Wa	Wet alluvial land-----	32	-----	----	VIIw-1	39	-----

1/  
This soil is in woodland suitability group 3. See page 45.

2/  
This soil is in woodland suitability group 2. See page 44.

3/  
This soil is in woodland suitability group 1. See page 44.

# NRCS Accessibility Statement

---

This document is not accessible by screen-reader software. The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at 1-800-457-3642 or by e-mail at [ServiceDesk-FTC@ftc.usda.gov](mailto:ServiceDesk-FTC@ftc.usda.gov). For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at <http://offices.sc.egov.usda.gov/locator/app>.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.



U. S. DEPARTMENT OF AGRICULTURE  
SOIL CONSERVATION SERVICE  
COLORADO AGRICULTURAL EXPERIMENT STATION

## GENERAL SOIL MAP

### CHAFFEE-LAKE AREA, COLORADO

### PARTS OF CHAFFEE AND LAKE COUNTIES

Scale 1:316,800  
1 0 1 2 3 4 5 Miles

#### SOIL ASSOCIATIONS

##### SOILS OF THE MOUNTAINS

- 1** Rock outcrop-Bross association: Rock outcrops and sloping to steep, deep soils at elevations of 10,000 to 14,000 feet
- 2** Troutville-Leadville association: Gently sloping to steep, deep, gravelly soils at elevations of 8,200 to 10,000 feet
- 3** Rock land-Rock outcrop association: Rock outcrops and steep and very steep, very shallow soils at elevations of 7,000 to 8,500 feet

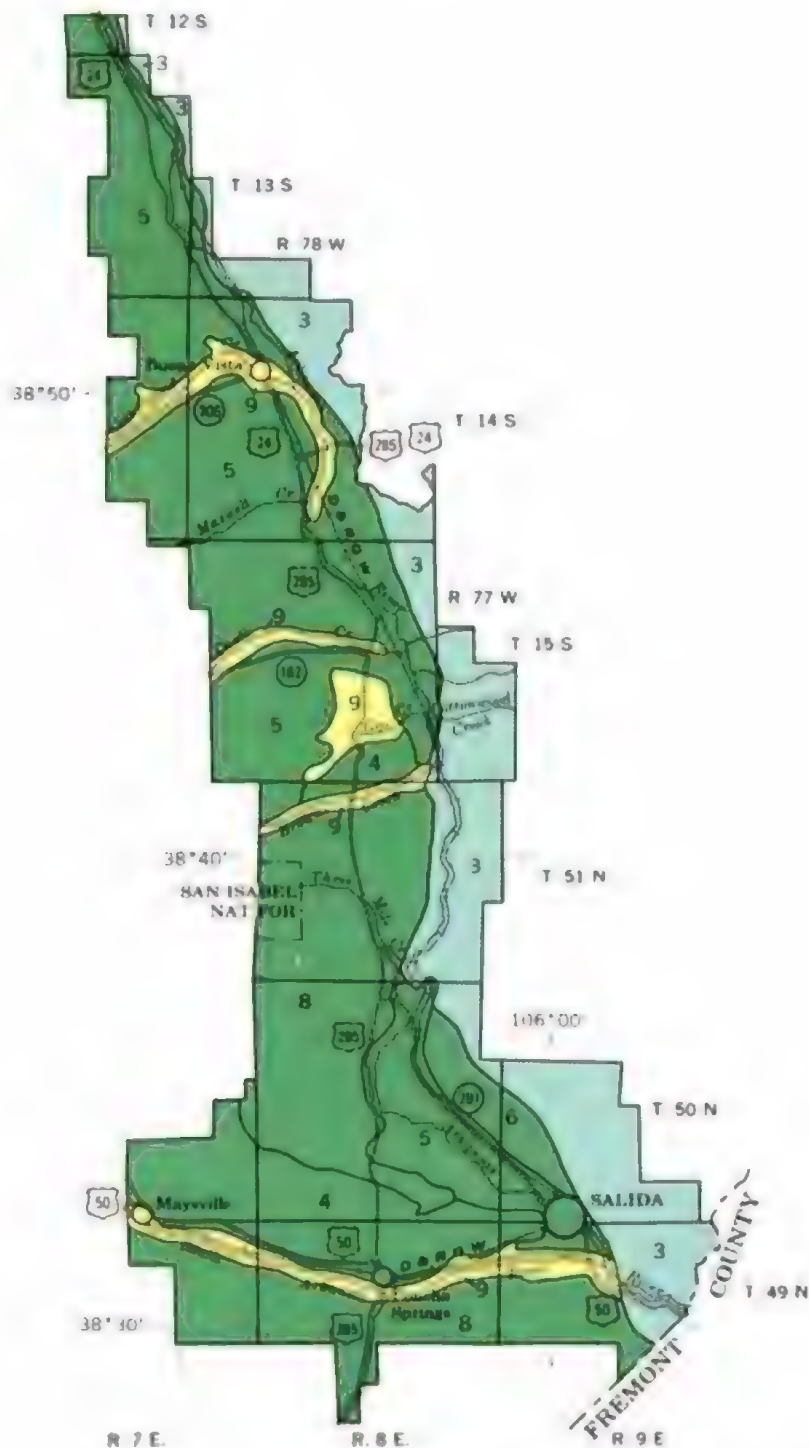
##### SOILS OF THE HIGH TERRACES

- 4** St. Elmo-Manhattan association: Nearly level to steep, deep, well-drained, limy soils
- 5** Dominson-San Isabel association: Nearly level to steep, deep, somewhat excessively drained soils
- 6** Cotopaxi-Ouray association: Nearly level to sloping, deep, well-drained soils
- 7** Pierian-Poncha association: Nearly level to steep, deep, well-drained soils
- 8** Rough broken land-Badland association: Moderately steep and steep, severely eroded sediments

##### SOILS OF THE TERRACES AND BOTTOM LANDS

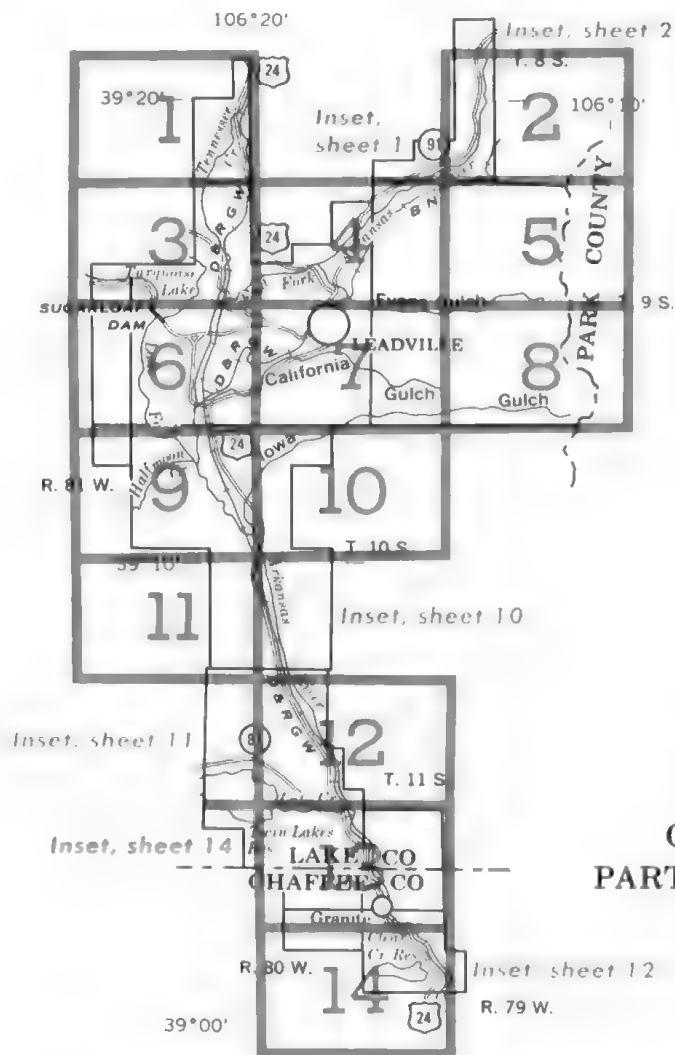
- 9** Wet alluvial land-Gas Creek association: Nearly level and gently sloping, deep, poorly drained soils
- 10** Newfork-Marsh-Rosane association: Nearly level and gently sloping, deep, poorly drained soils subject to floods; and marshes

Compiled 1972



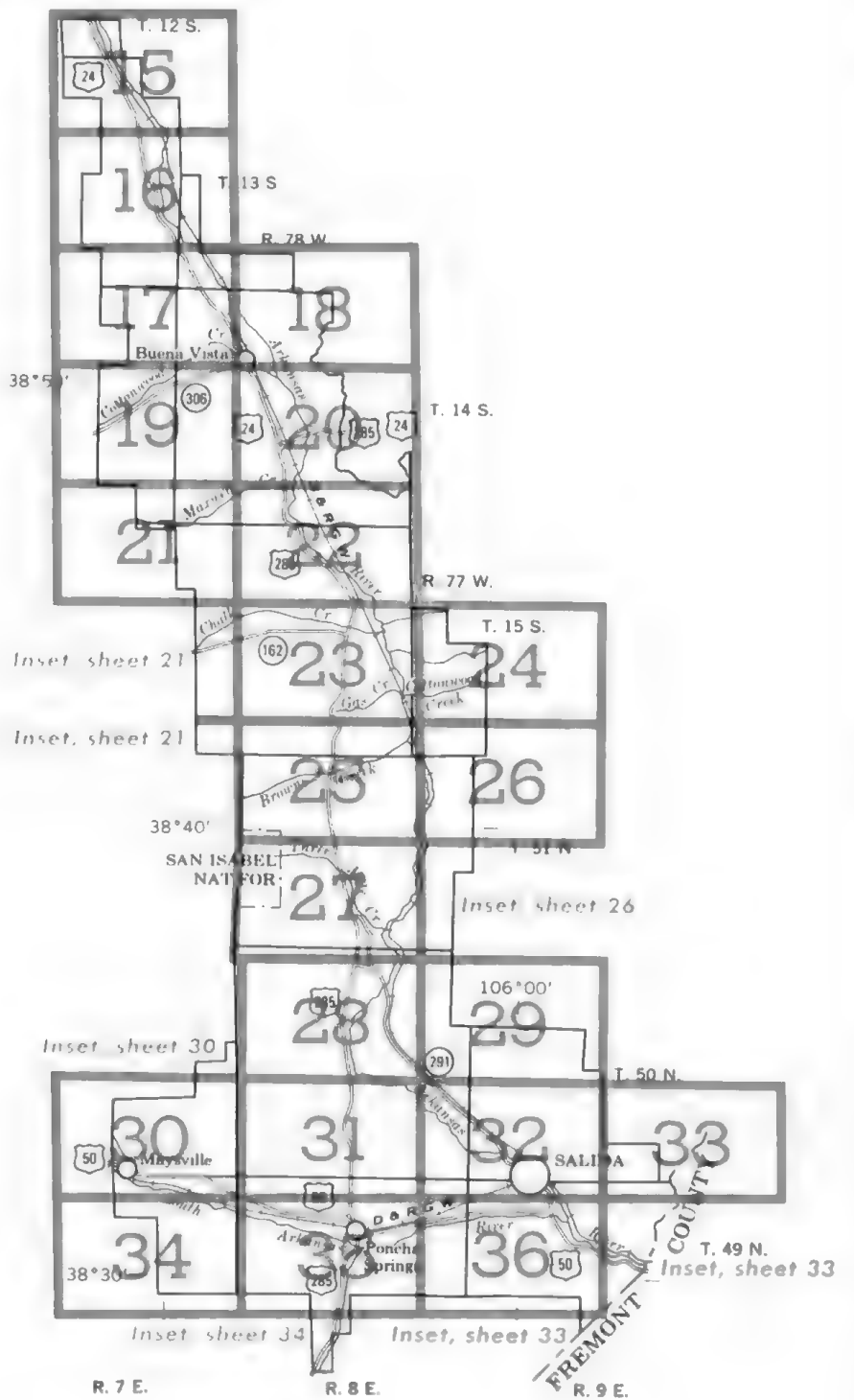
Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.





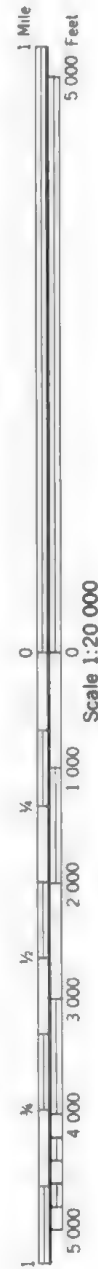
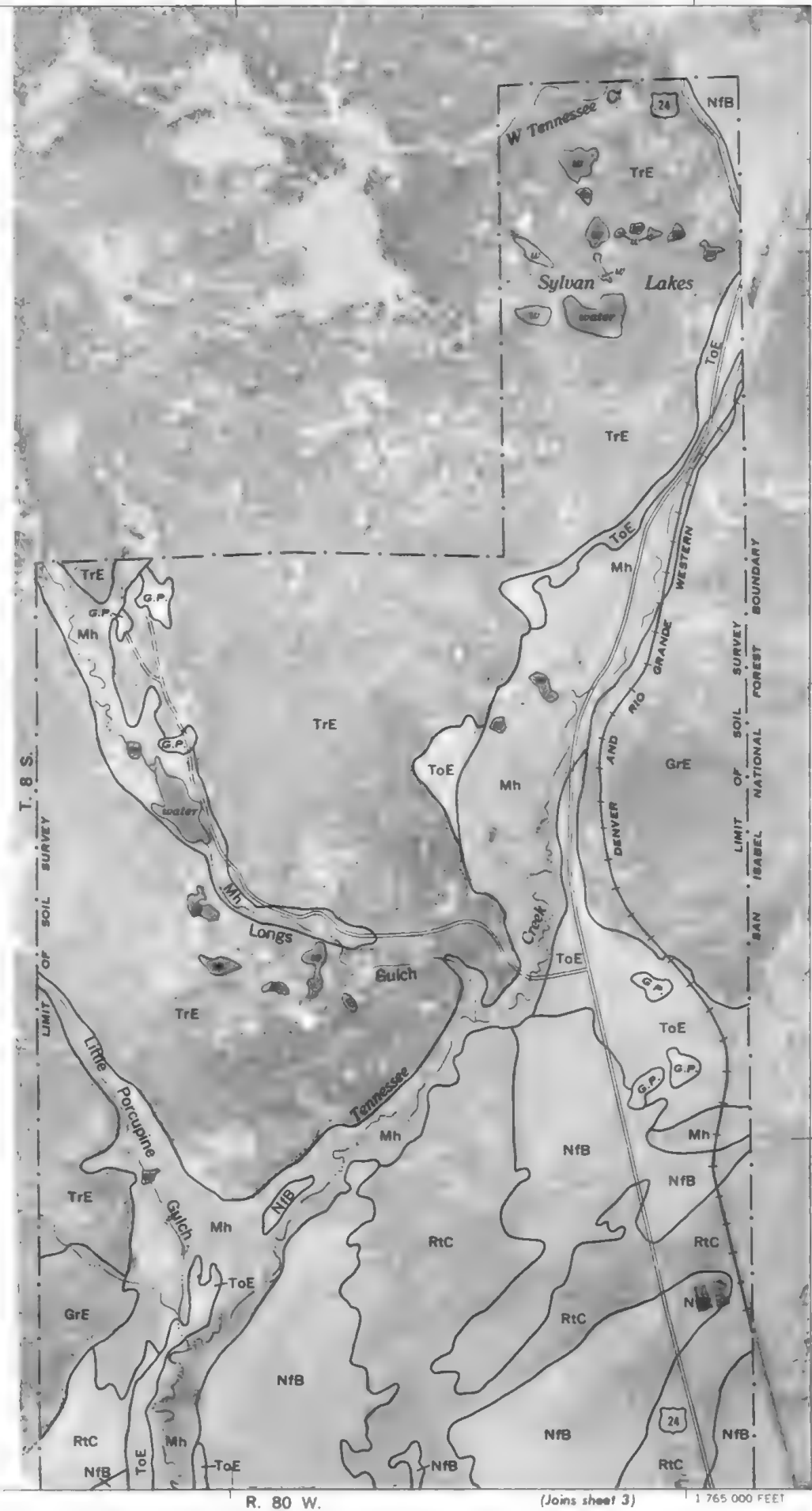
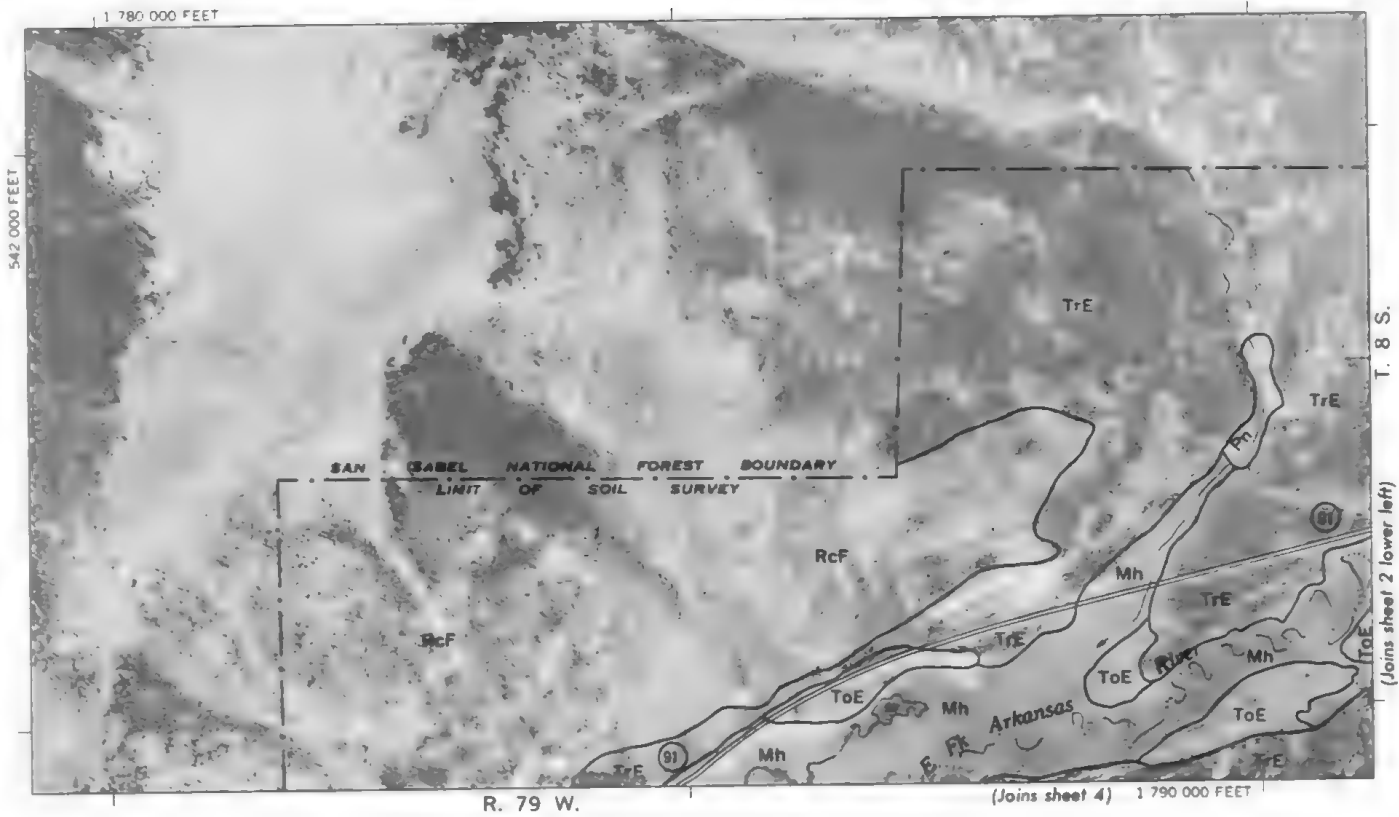
# INDEX TO MAP SHEETS CHAFFEE-LAKE AREA, COLORADO PARTS OF CHAFFEE AND LAKE COUNTIES

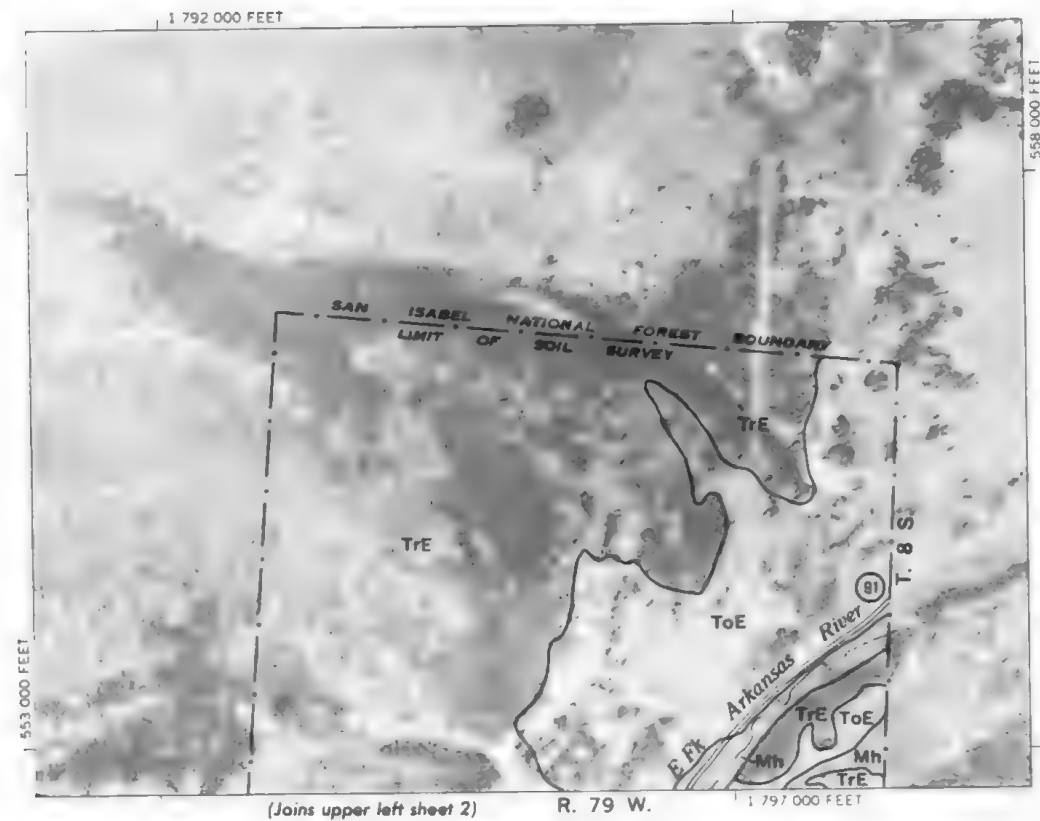
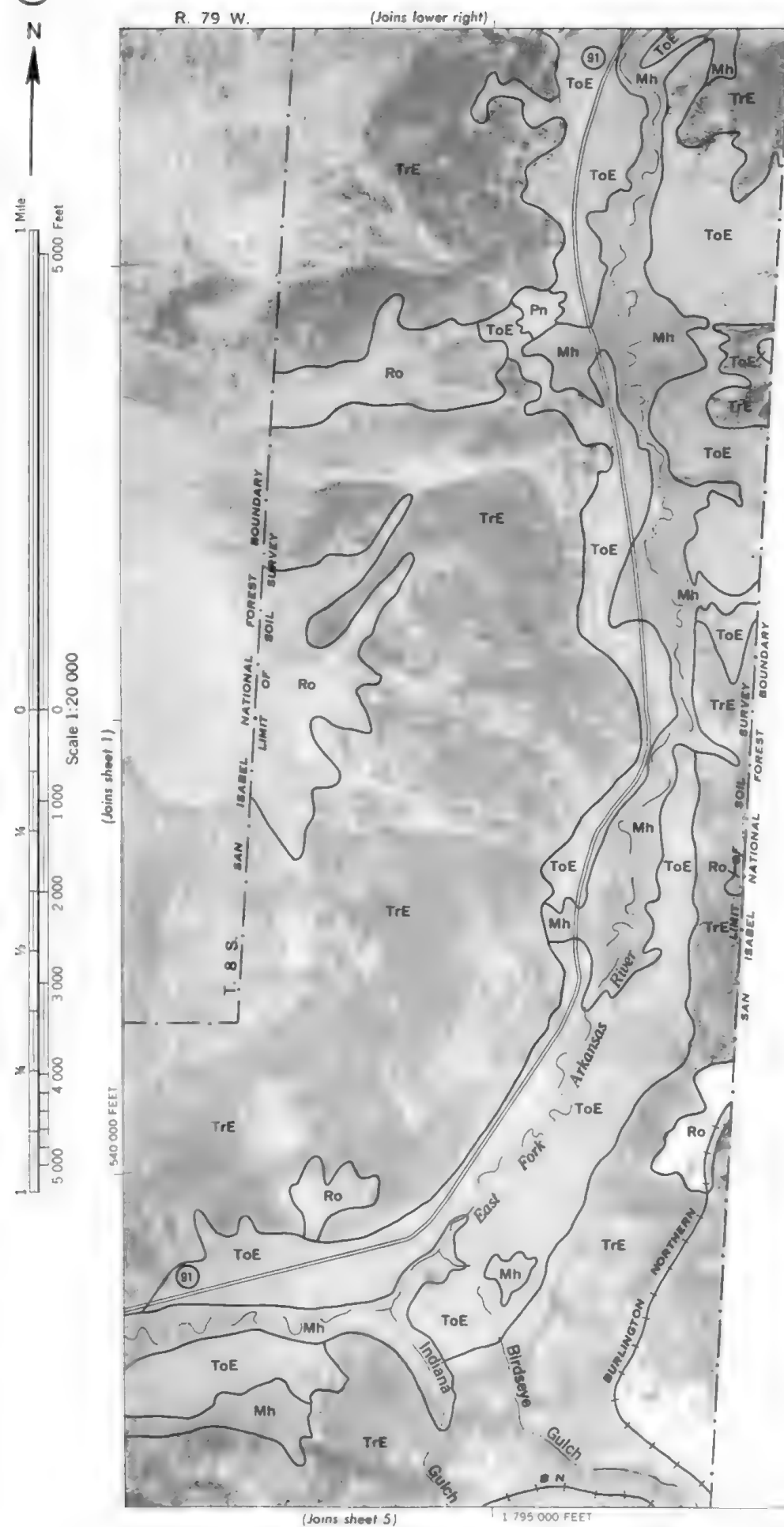
Scale 1:316,800  
1 0 1 2 3 4 5 Miles





This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Colorado Agricultural Experiment Station. Photobase from 1956, 1957 and 1967 aerial photography. 5,000-foot grid ticks are approximate and based on Colorado plane coordinate system, south zone 1927 North American datum. Land division corners are approximately positioned on this map.





Photobase from 1956, 1957 and 1967 aerial photography. 5,000 foot grid ticks are approximate and based on Colorado plane coordinate system, south zone 1927 North American datum. This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Colorado Agricultural Experiment Station.



This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Colorado Agricultural Experiment Station. Photobase from 1956, 1957 and 1967 aerial photography. 5,000-foot grid ticks are approximate and based on Colorado plane coordinate system, south zone, 1927 North American datum. Land division corners are approximately positioned on this map.

(Joins sheet 4)

(Joins sheet 6) 1 765 000 FEET



4



1 Mile

5 000 Feet

Scale 1:20 000

0

1 000

2 000

3 000

4 000

5 000



(Joins sheet 7)

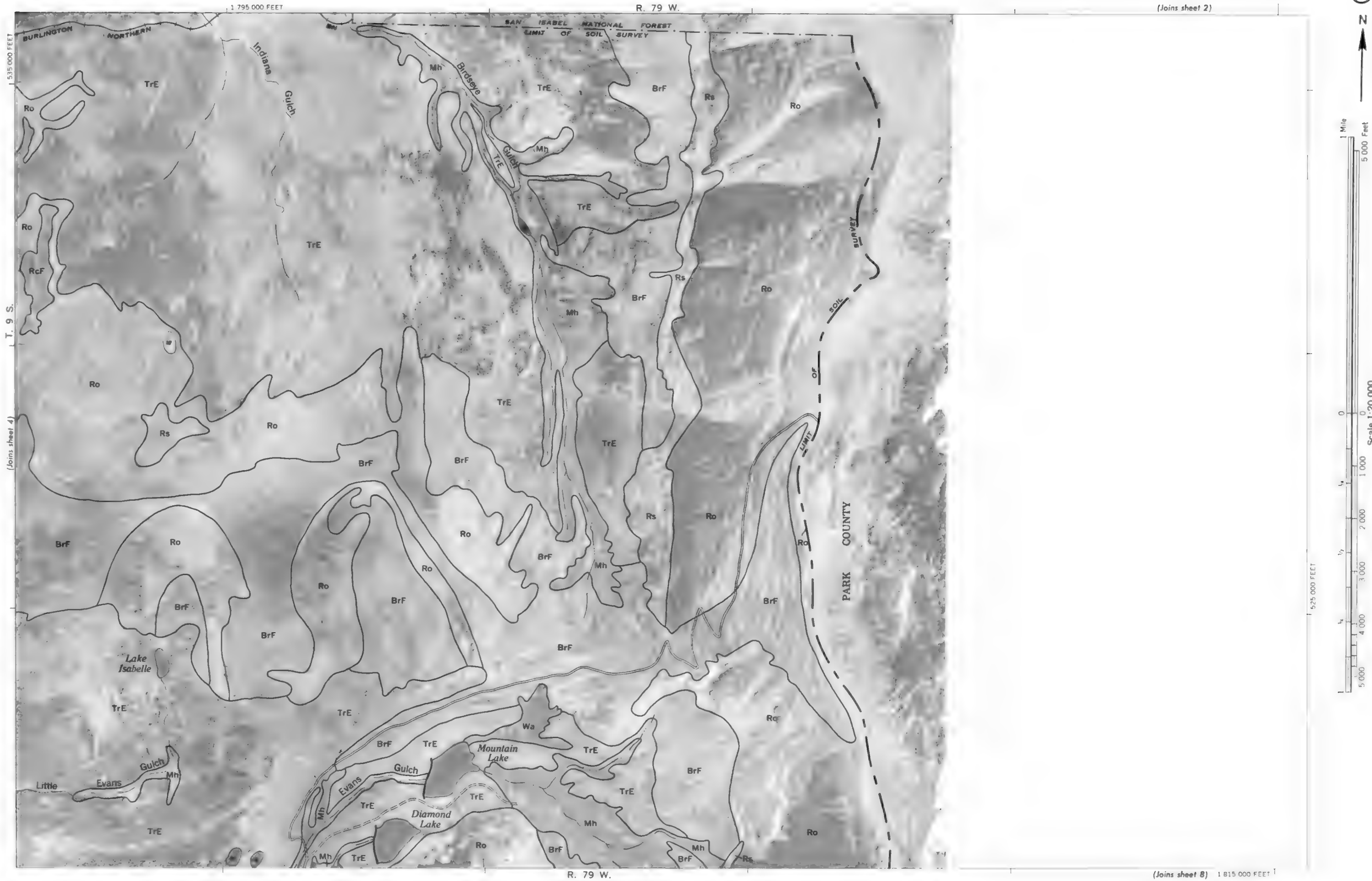
1 790 000 FEET

(Joins sheet 5)

T. 9 S.

Land division corners are approximately positioned on this map. Photobase from 1946, 1957 and 1967 aerial photography. 5,000 foot grid lines are approximate and based on Colorado plane coordinate system, south zone 1927 North American datum. This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Colorado Agricultural Experiment Station.





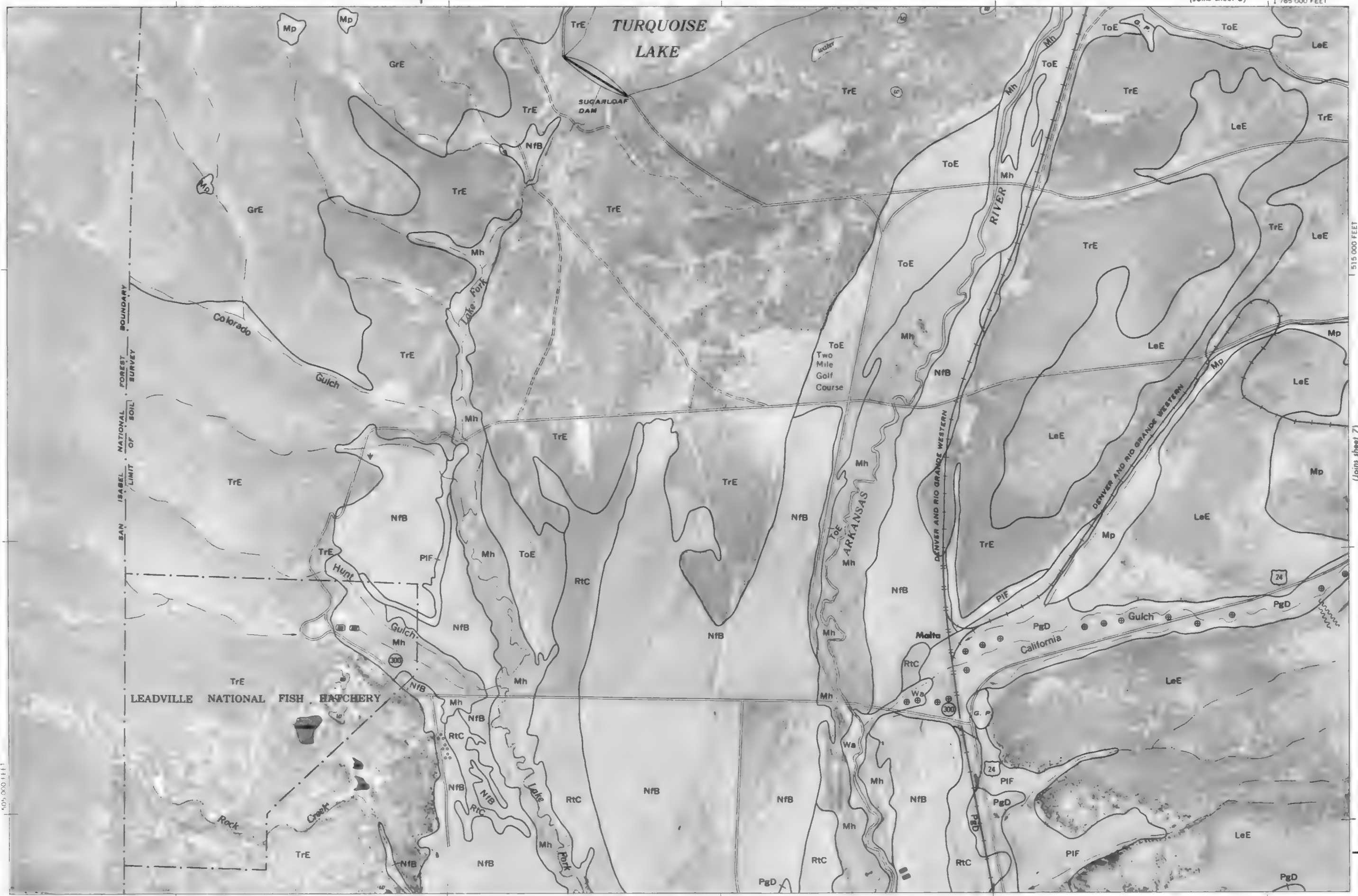
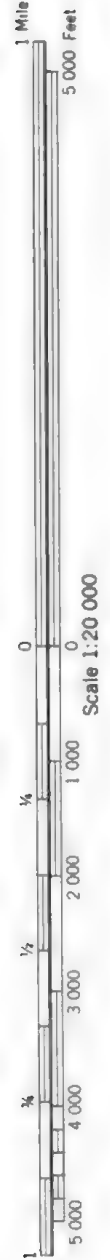
This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Colorado Agricultural Experiment Station. Photobase from 1956, 1957 and 1967 aerial photography. 5,000 foot grid ticks are approximate and based on Colorado plane coordinate system, south zone 1927 North American datum. Land division corners are approximately positioned on this map.

(Joins sheet 4)

(Joins sheet 8) 1 815 000 FEET

R. 81 W. | R. 80 W.

(Joins sheet 3) 1 765 000 FEET



1 745 000 FEET (Joins sheet 9)

515 000 FEET (Joins sheet 7)

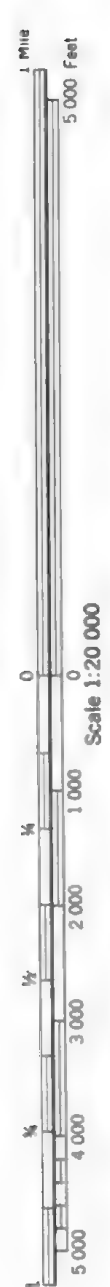
T. 10 S. | T. 9 S.

Land division corners are approximately positioned on this map.  
Photobase from 1956, 1957 and 1967 aerial photography. 5,000 foot grid ticks are approximate and based on Colorado plane coordinate system, south zone 1927 North American datum.  
This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Colorado Agricultural Experiment Station.

T. 10 S. | T. 9 S.

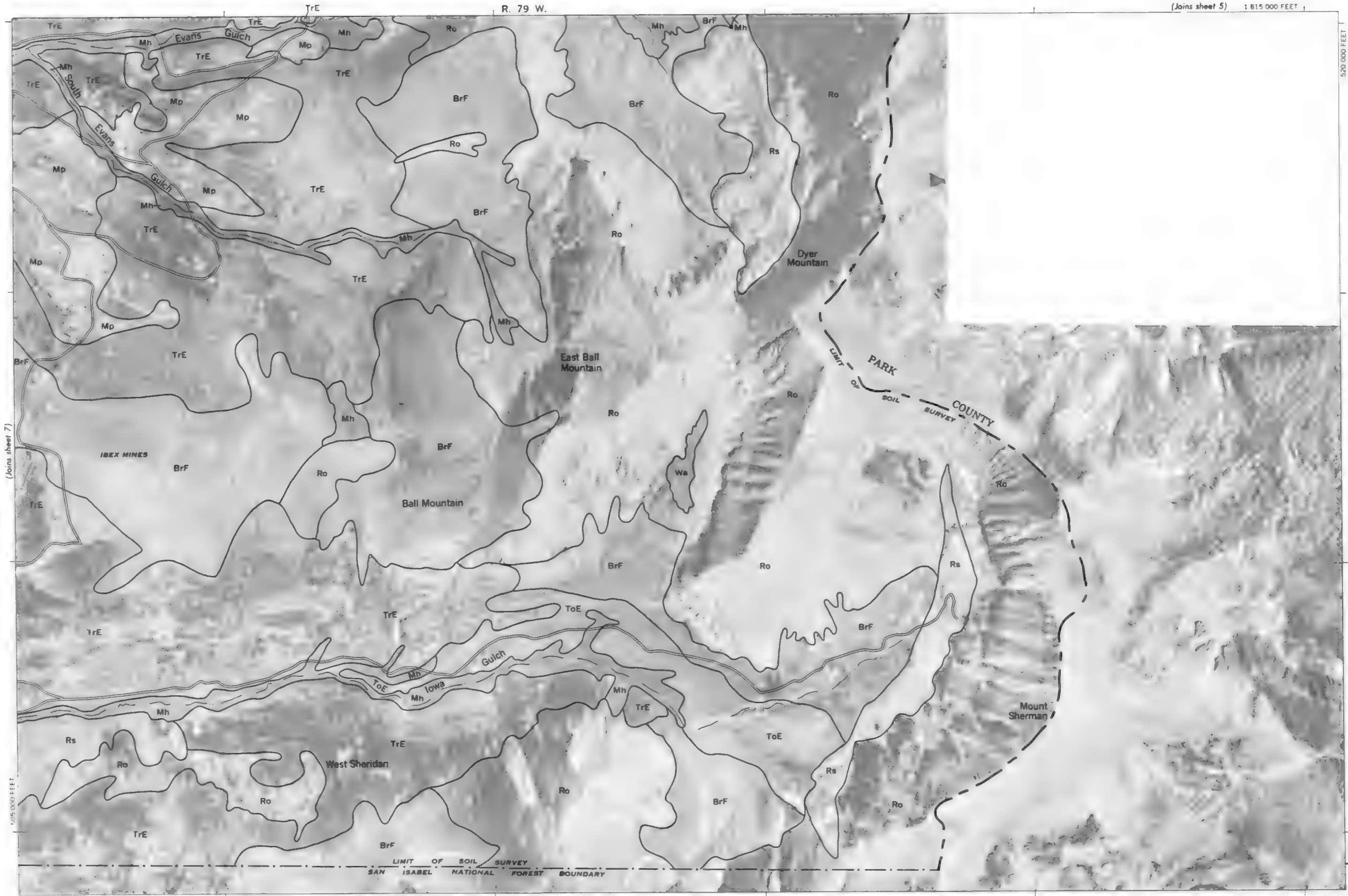






R. 79 W.

(Joins sheet 5) 1 815 000 FEET



520 000 FEET

T. 10 S. T. 9 S.

Land division corners are approximately positioned on this map  
Photobase from 1956, 1957 and 1967 aerial photography 5,000 foot grid ticks are approximate and based on Colorado plane coordinate system, south zone 1927 North American datum  
This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Colorado Agricultural Experiment Station.

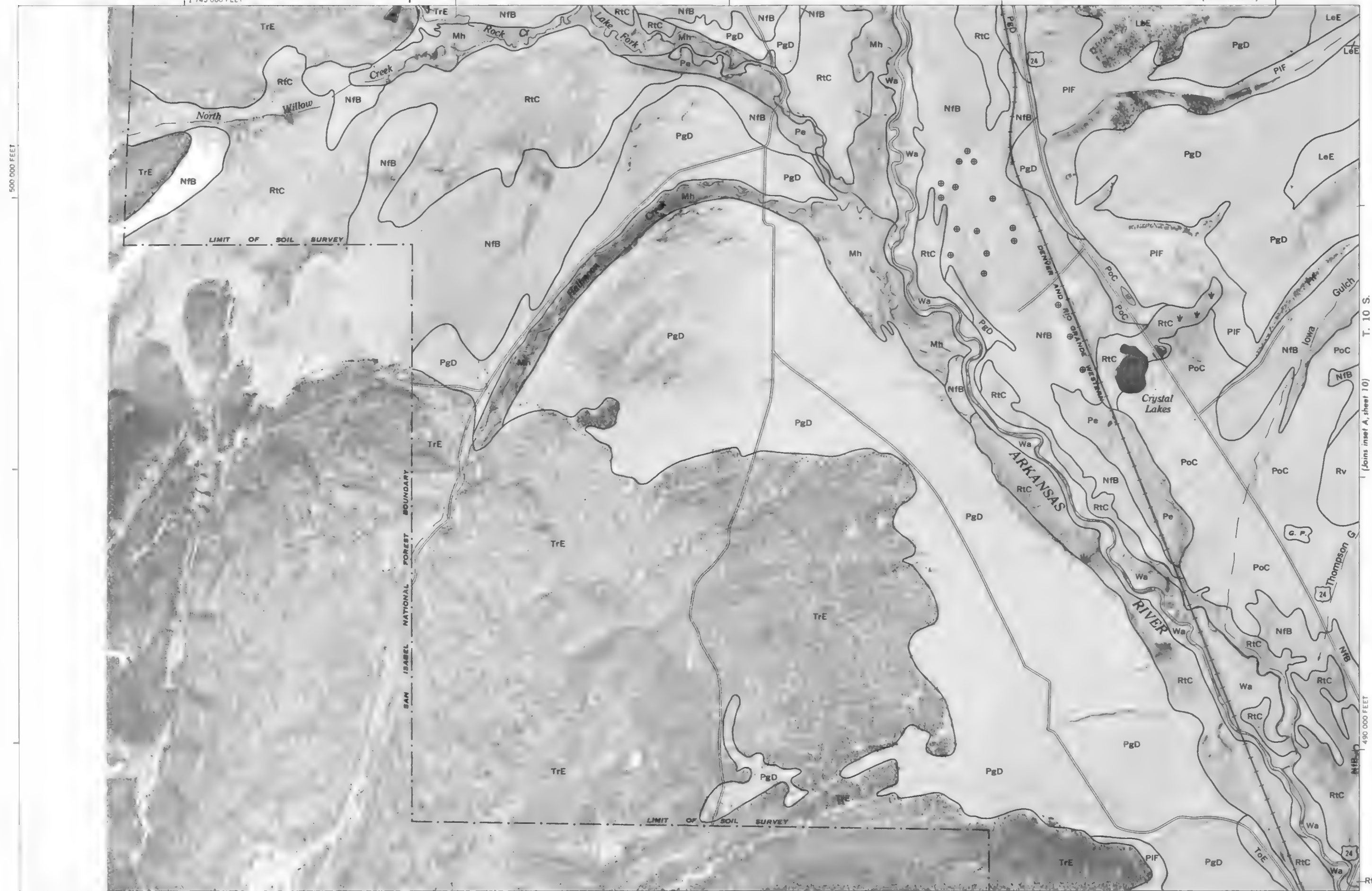
This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Colorado Agricultural Experiment Station. Photobase from 1956, 1957 and 1967 aerial photography. 5,000 foot grid ticks are approximate and based on Colorado plane coordinate system, south zone 1927 North American datum. Land division corners are approximately positioned on this map.

CHAFFEE LAKE AREA, COLORADO — SHEET NUMBER 9

R. 81 W. | R. 80 W.

1 745 000 FEET

(Joins sheet 6)



9

N

1 Mile  
0 1 2 3 4 5  
0 1 000 2 000 3 000 4 000 5 000 Feet  
Scale 1:20 000

1 490 000 FEET

(Joins sheet 11) 1 765 000 FEET



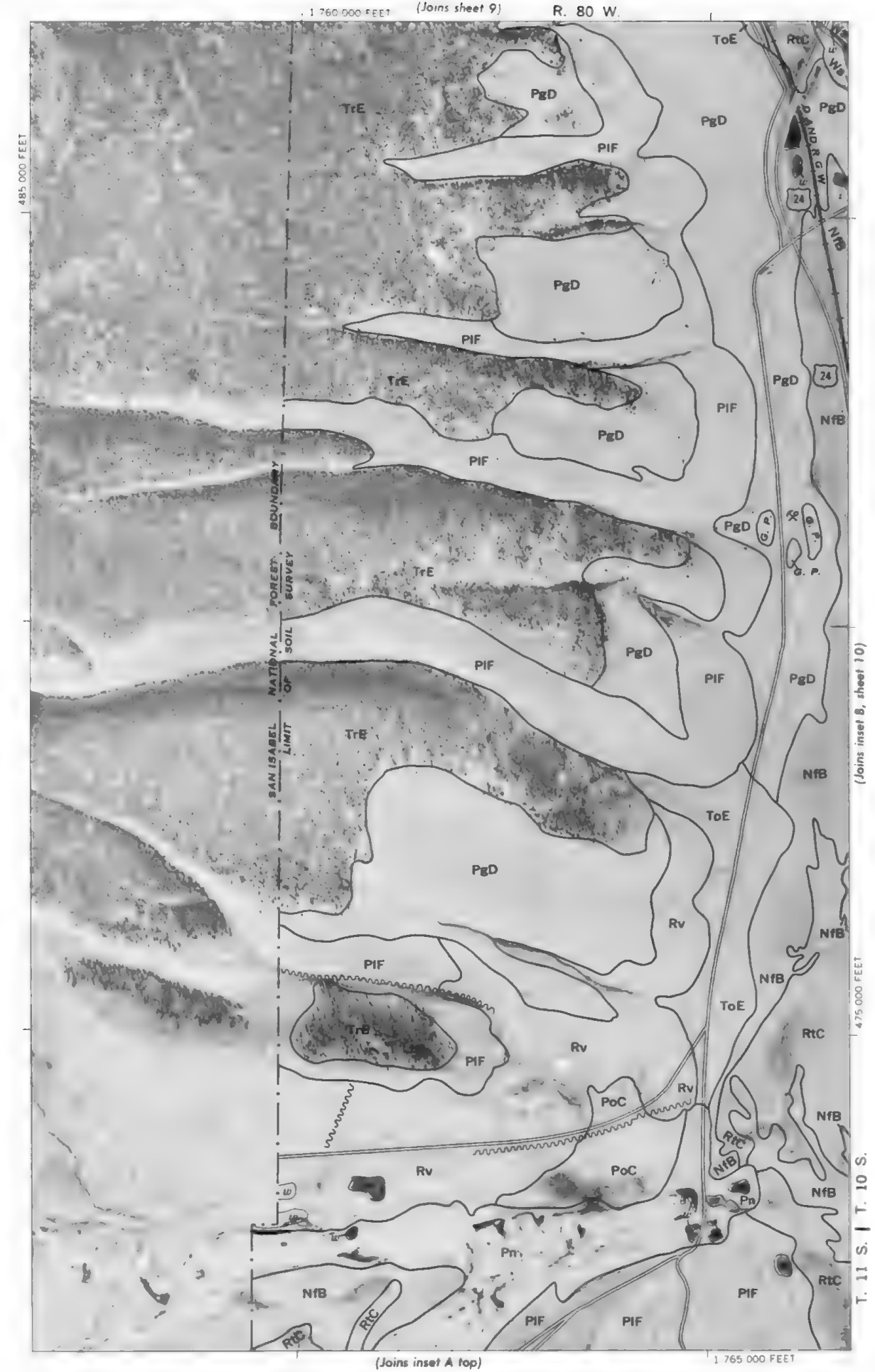
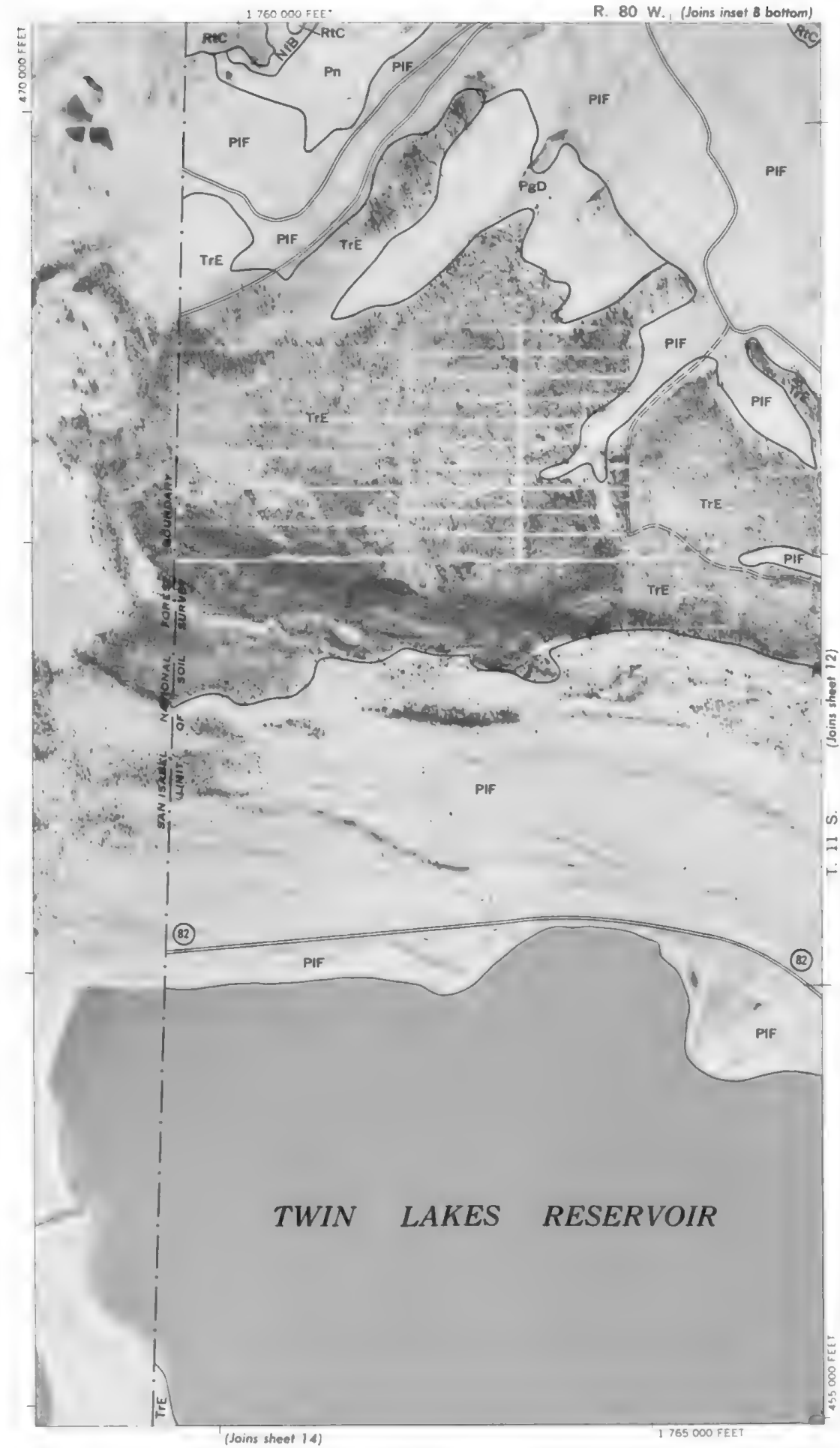
Land division corners are approximately positioned on this map.

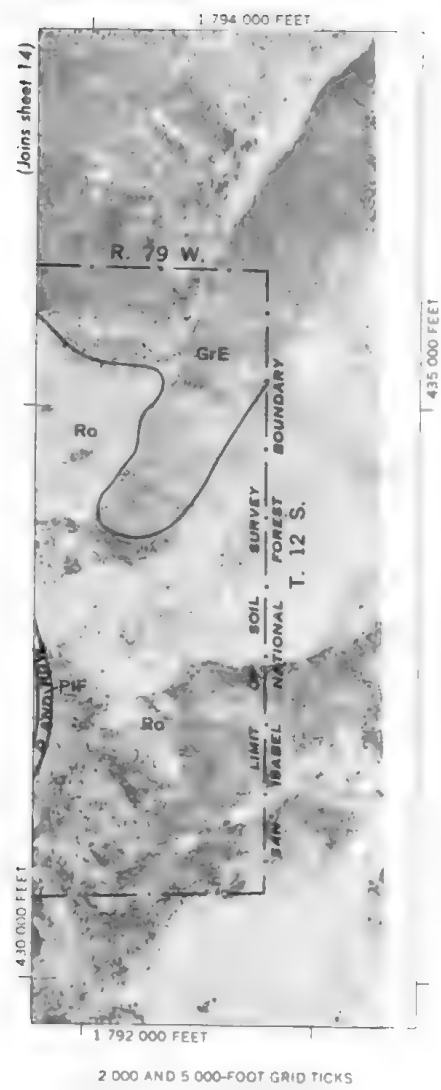
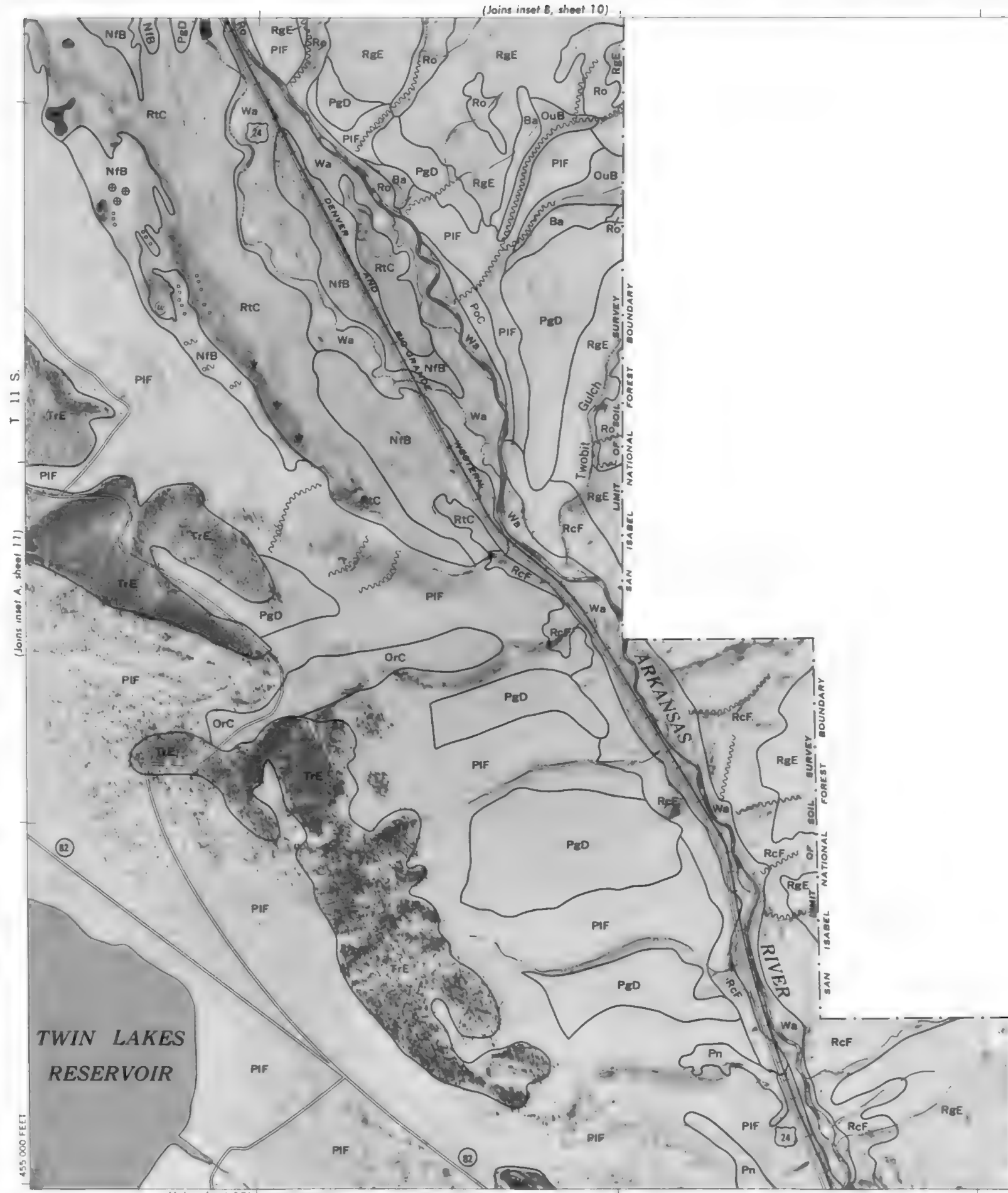
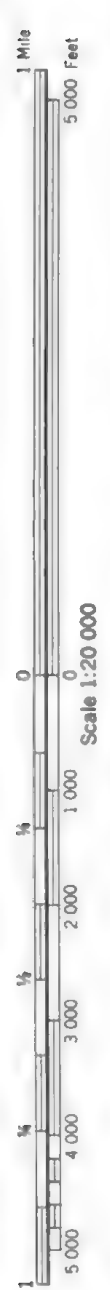
Photobase from 1956, 1957 and 1967 aerial photography. 5,000 foot grid ticks are approximate and based on Colorado plane coordinate system, south zone 1927 North American datum.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Colorado Agricultural Experiment Station.



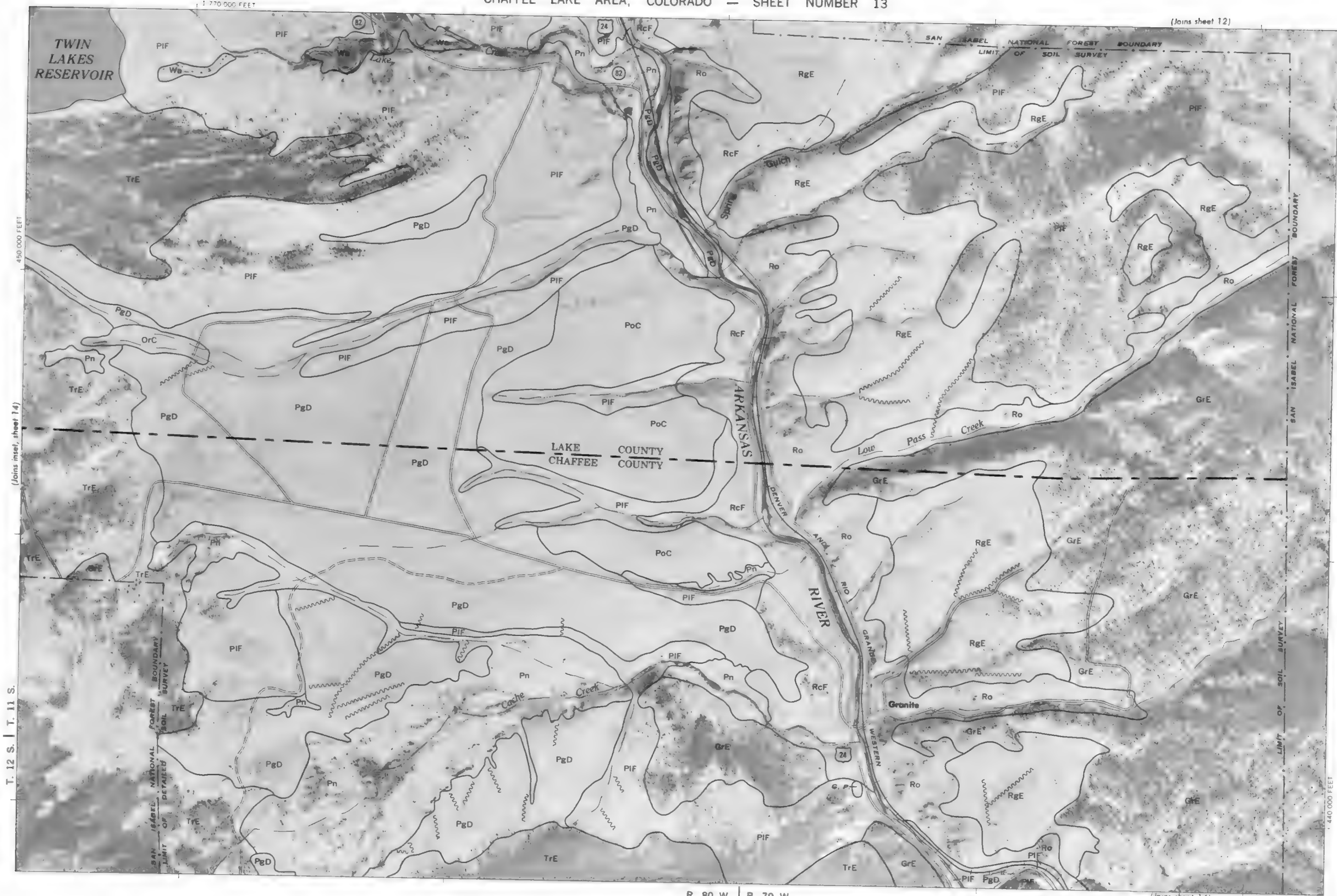
This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Colorado Agricultural Experiment Station. Photobase from 1956, 1957 and 1967 aerial photography. 5,000 foot grid ticks are approximate and based on Colorado plane coordinate system, south zone 1927 North American datum. Land division corners are approximately positioned on this map.



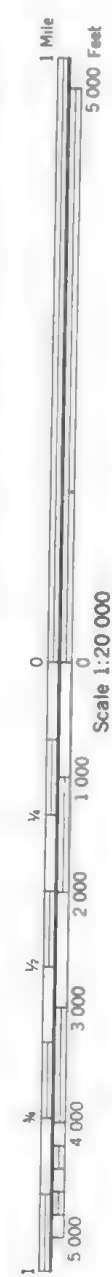


Photobase from 1956, 1957 and 1967 aerial photography. 5,000 foot grid ticks are approximate and based on Colorado plane coordinate system, south zone 1927 North American datum. This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Colorado Agricultural Experiment Station.

(Joins sheet 12)



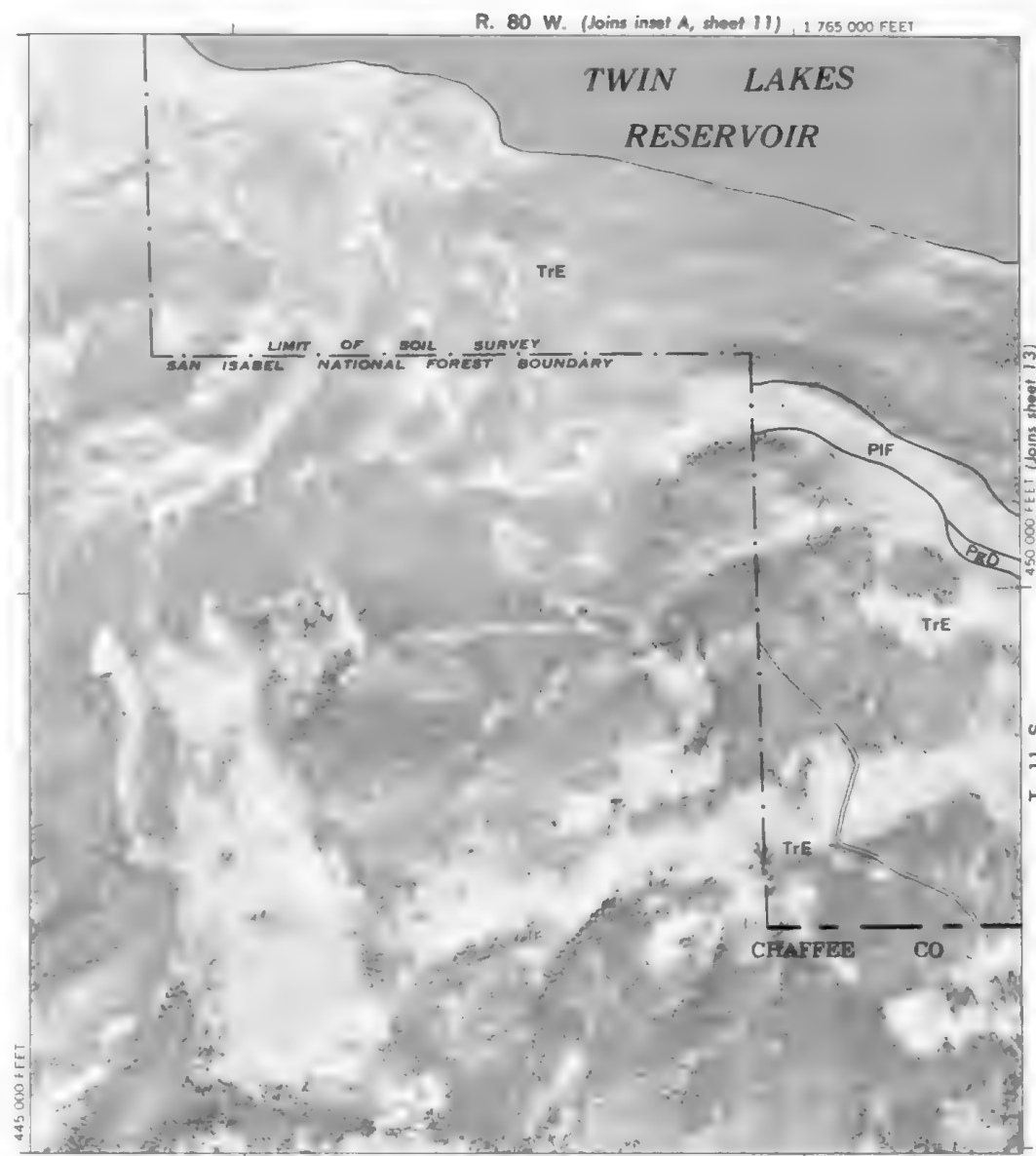
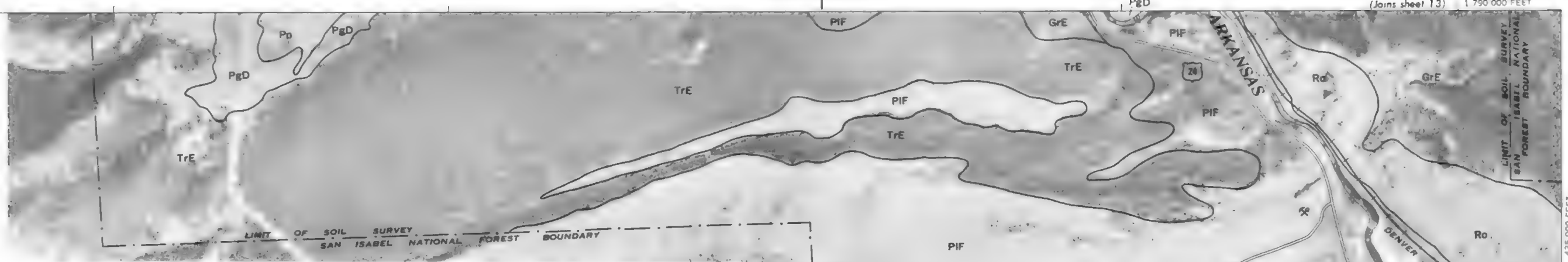
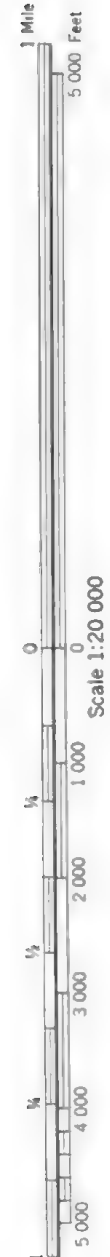
This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Colorado Agricultural Experiment Station. Photocopy from 1956, 1957 and 1967 aerial photography. U.S. foot and grid ticks are approximate and based on Colorado plane coordinate system, south zone, 1927 North American datum. Land division corners are approximately positioned on this map.



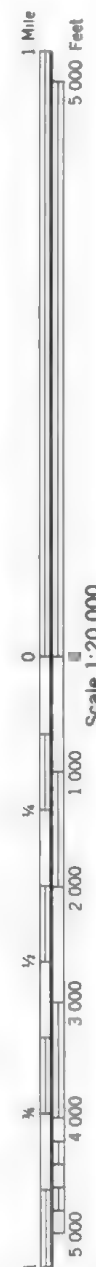
(Joins sheet 14)

1:20,000 FEET



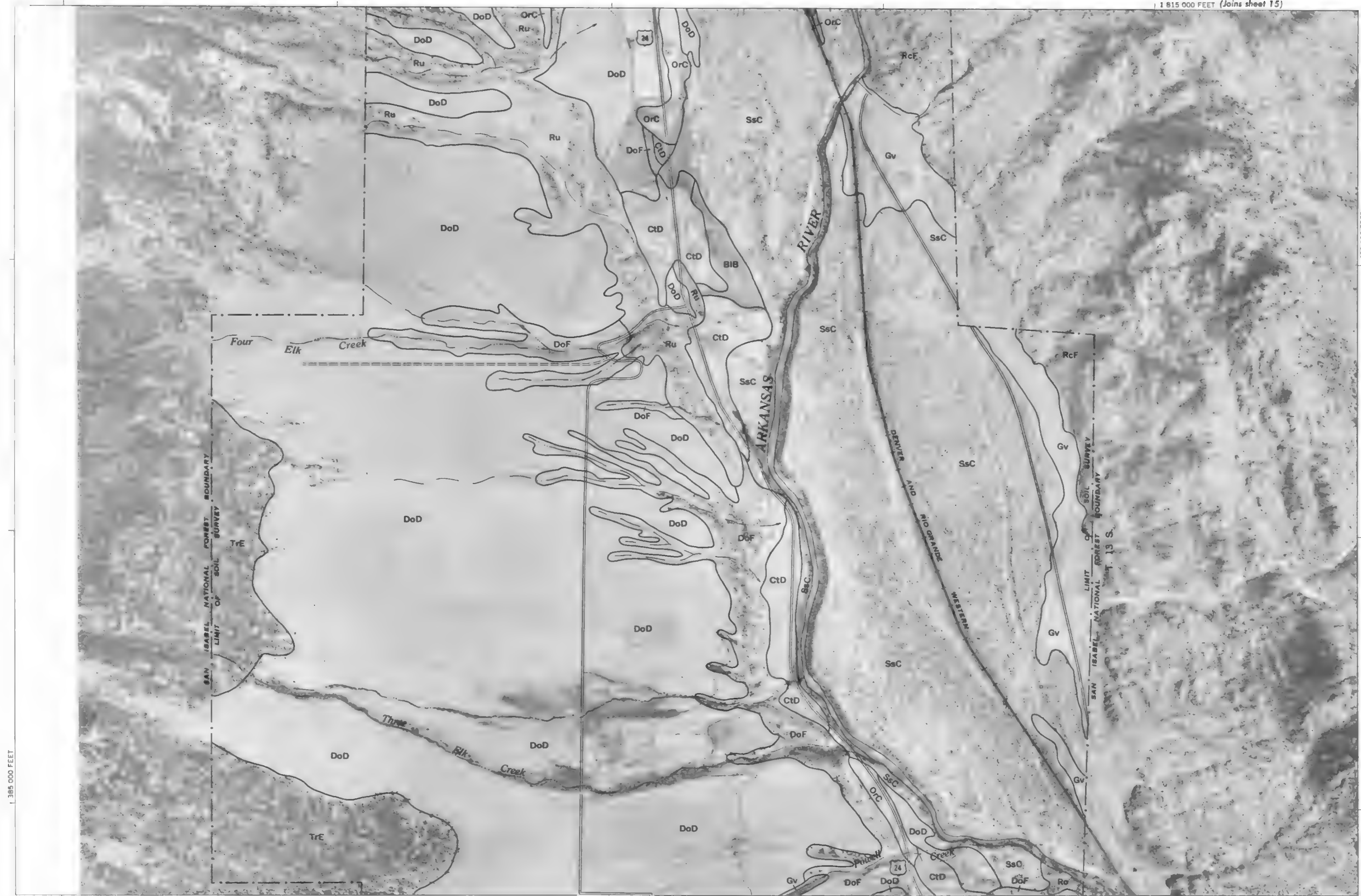


T. 13 S. | T. 12 S.



1 815 000 FEET (Joins sheet 16)





1 385 000 FEET

1 395 000 FEET

1 795 000 FEET (Joins sheet 17)

R. 79 W. | R. 78 W.

Photobase from 1956, 1957 and 1967 aerial photography. 5,000 foot grid ticks are approximate and based on Colorado plane coordinate system, south zone 1927 North American datum. This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Colorado Agricultural Experiment Station.

Land division corners are approximately positioned on this map.



This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Colorado Agricultural Experiment Station. Photobase from 1956, 1957 and 1967 aerial photography. 5,000 foot grid ticks are approximate and based on Colorado plane coordinate system, south zone, 1927 North American datum. Land division corners are approximately positioned on this map.

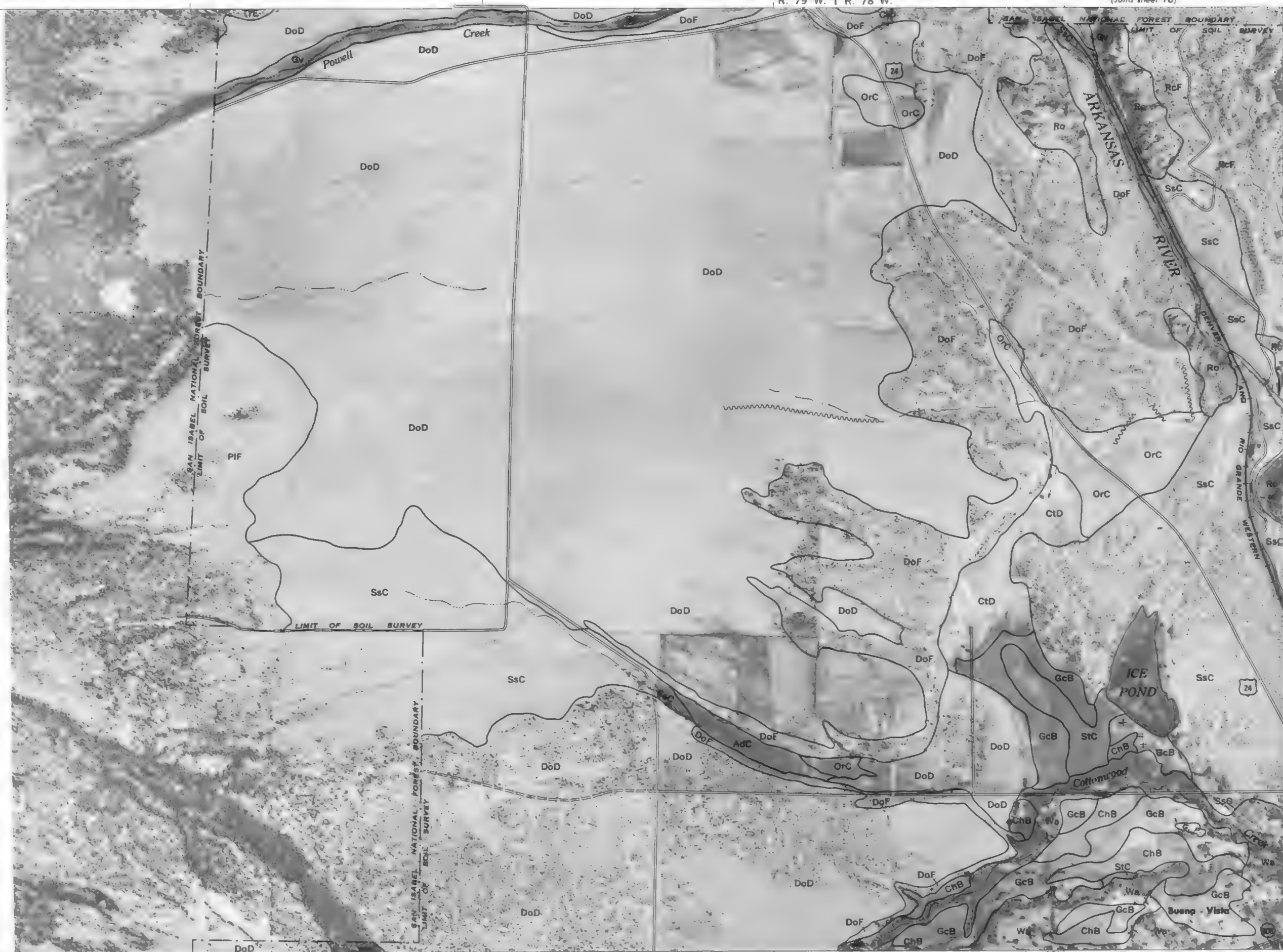
T. 14 S. | T. 13 S.

380 000 FEET

1 795 000 FEET

R. 79 W. | R. 78 W.

(Joins sheet 16)

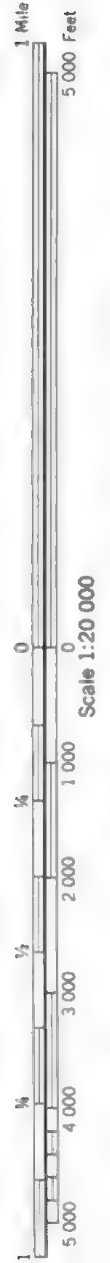


(Joins sheet 19) 1 815 000 FEET



R. 78 W.

1 840 000 FEET

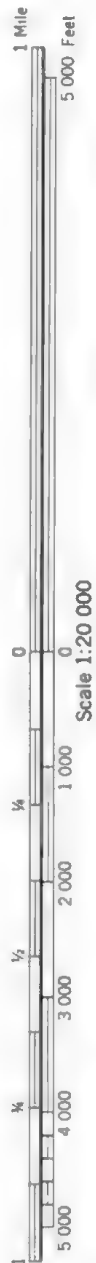
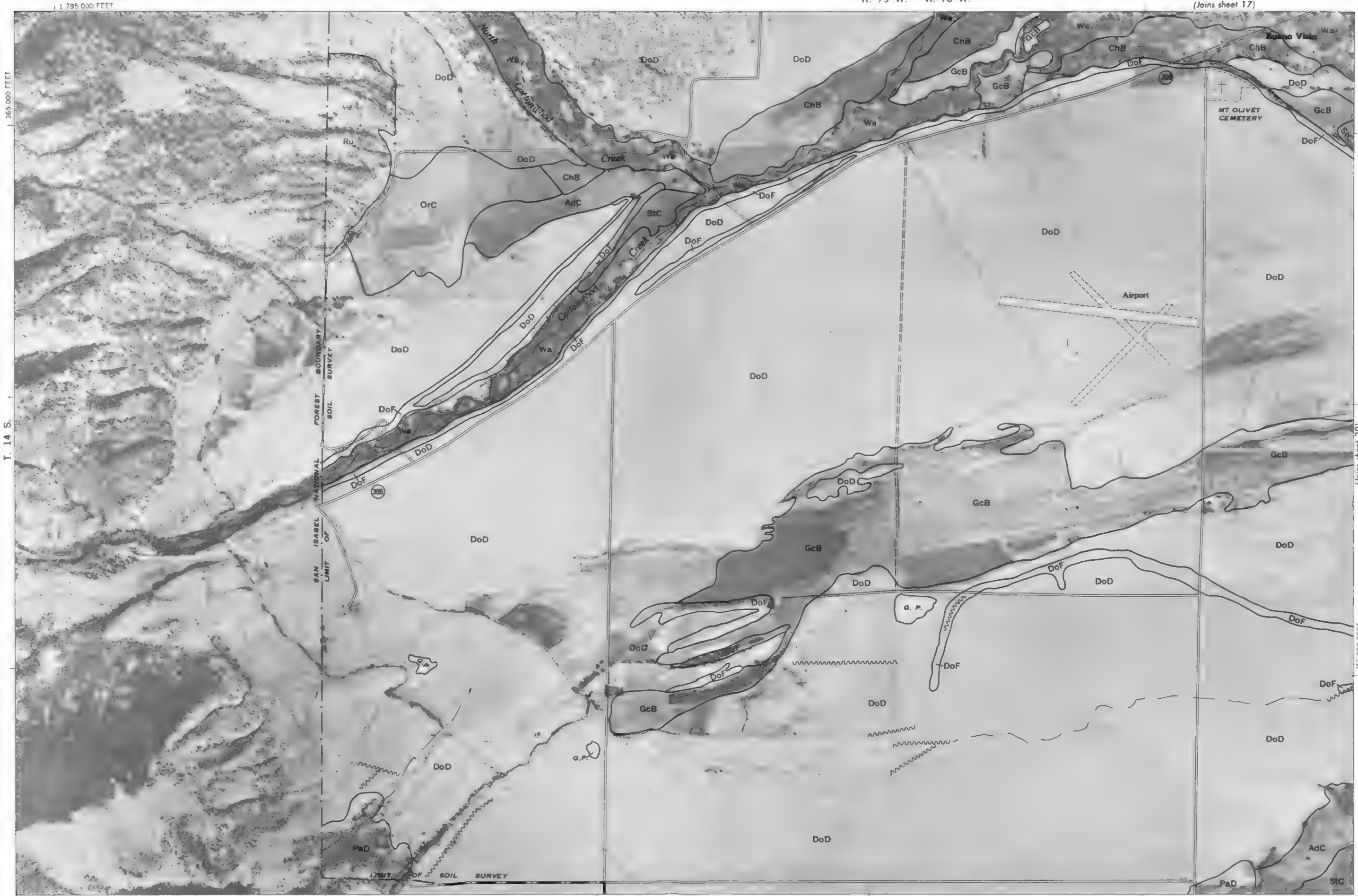


T. 14 S. | T. 13 S.

Photobase from 1956, 1957 and 1967 aerial photography. 5,000 foot grid ticks are approximate and based on Colorado plane coordinate system, south zone. 1927 North American datum. This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Colorado Agricultural Experiment Station.



This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Colorado Agricultural Experiment Station. Photobase from 1956, 1957, and 1967 aerial photographs. 5,000 foot grid ticks are approximate and based on Colorado plane coordinate system, south zone, 1922 North American datum. Land division corners are approximately positioned on this map.

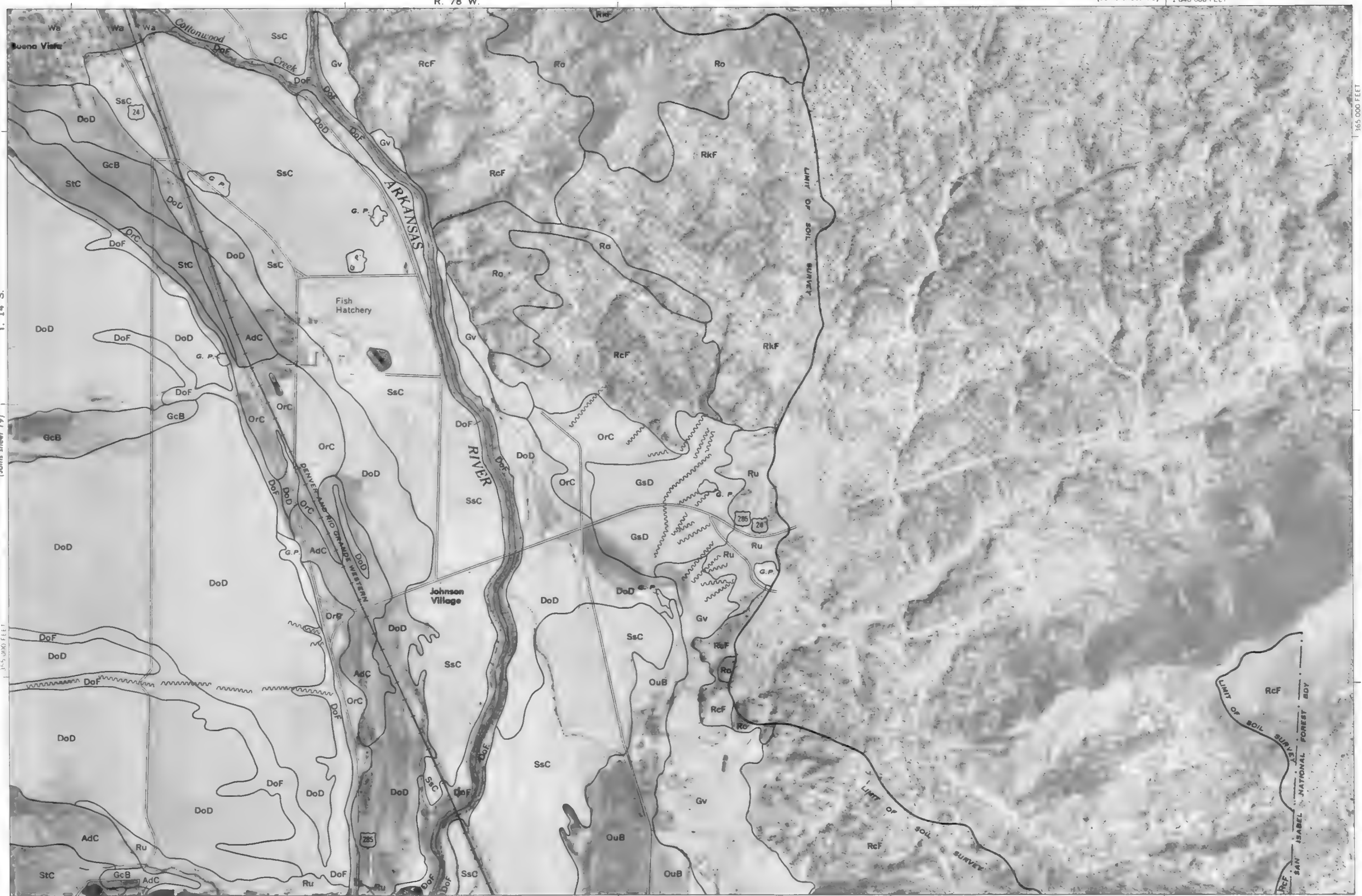


R. 78 W.

(Joins sheet 18) 1 840 000 FEET



T. 14 S.  
(Joins sheet 19)



1 820 000 FEET (Joins sheet 22)

365 000 FEET

Land division corners are approximately positioned on this map  
Photobase from 1956, 1957 and 1967 aerial photography 5,000 foot grid ticks are approximate and based on Colorado plane coordinate system, south zone 1927 North American datum  
This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Colorado Agricultural Experiment Station



1 805 000 FEET

1 814 000 FEET

1 818 000 FEET

314 000 FEET

318 000 FEET

322 000 FEET

R. 78 W.

T. 15 S.

PaD

CtD

DoF

RU

INSET B

4 000 - FOOT GRID TICKS

1 805 000 FEET

1 814 000 FEET

1 818 000 FEET

314 000 FEET

318 000 FEET

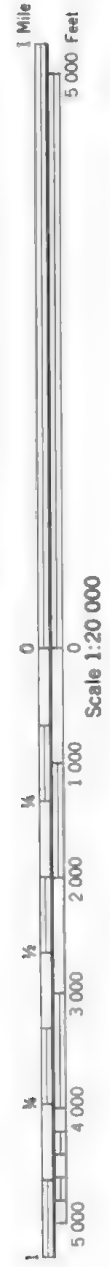
322 000 FEET

San Isabel National Forest Boundary

Limit of Soil Survey

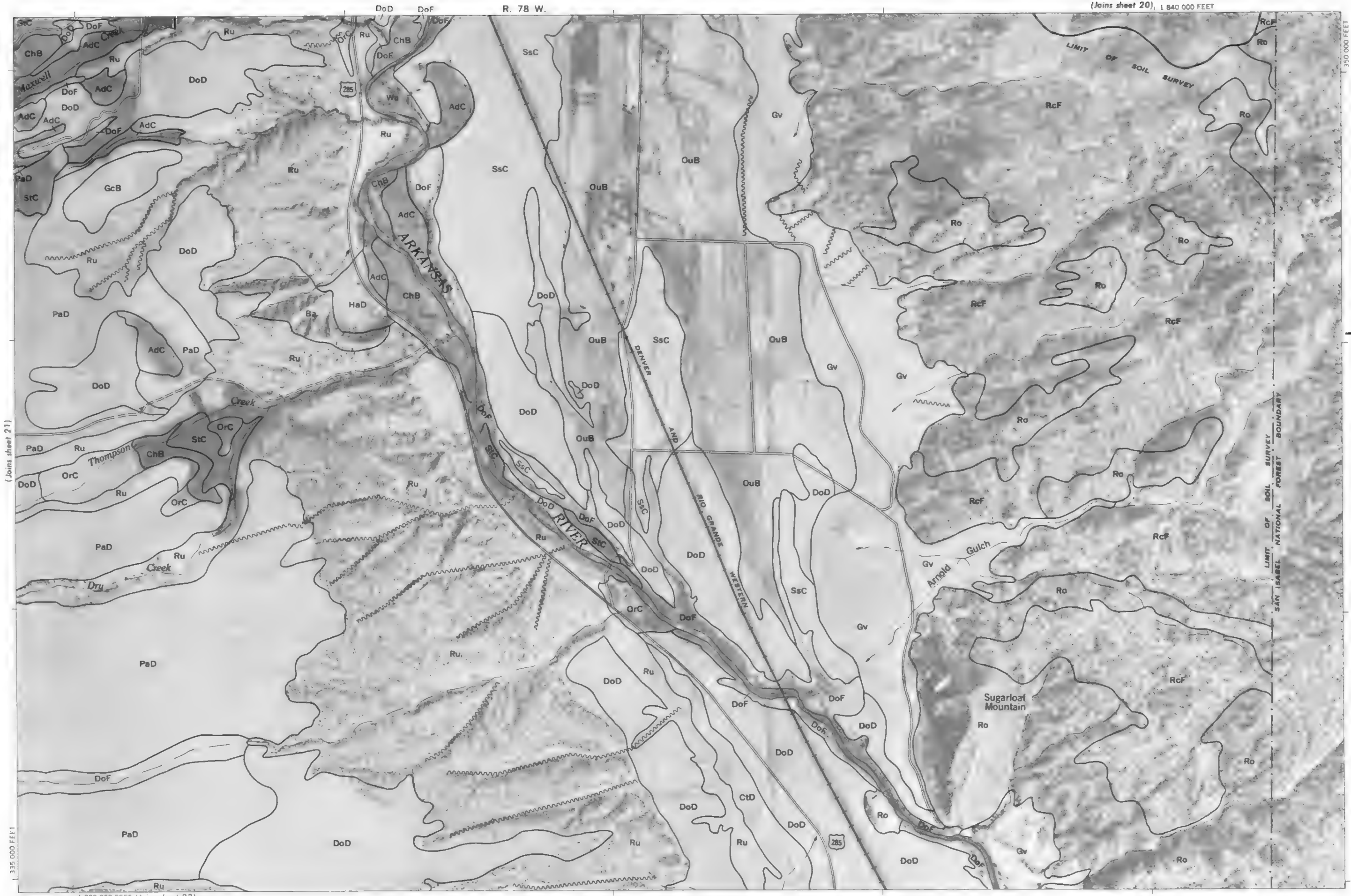
Joins inset A bottom

Joins sheet 25



R. 78 W.

(Joins sheet 20), 1 840 000 FEET



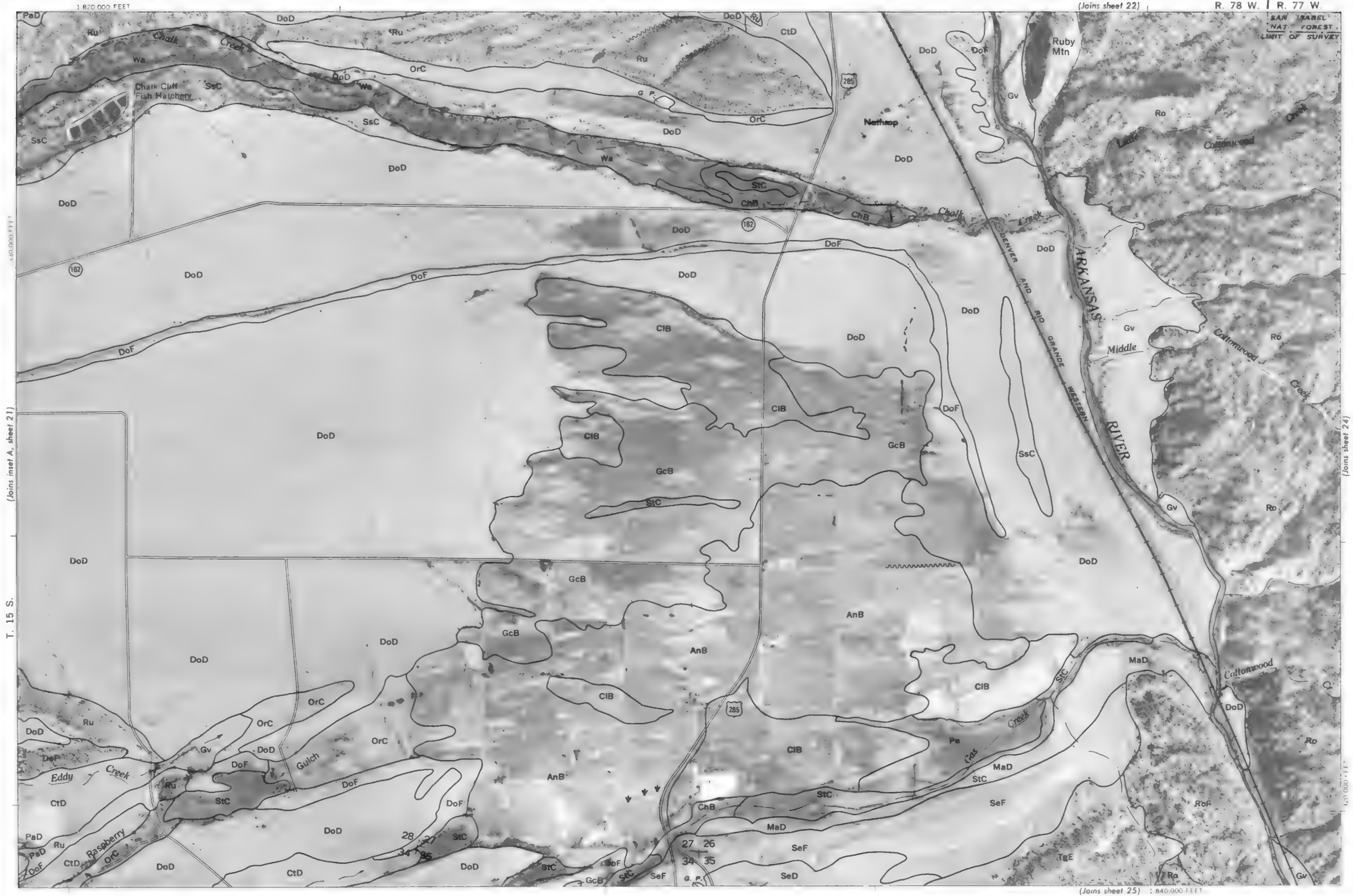
1 820 000 FEET (Joins sheet 23)

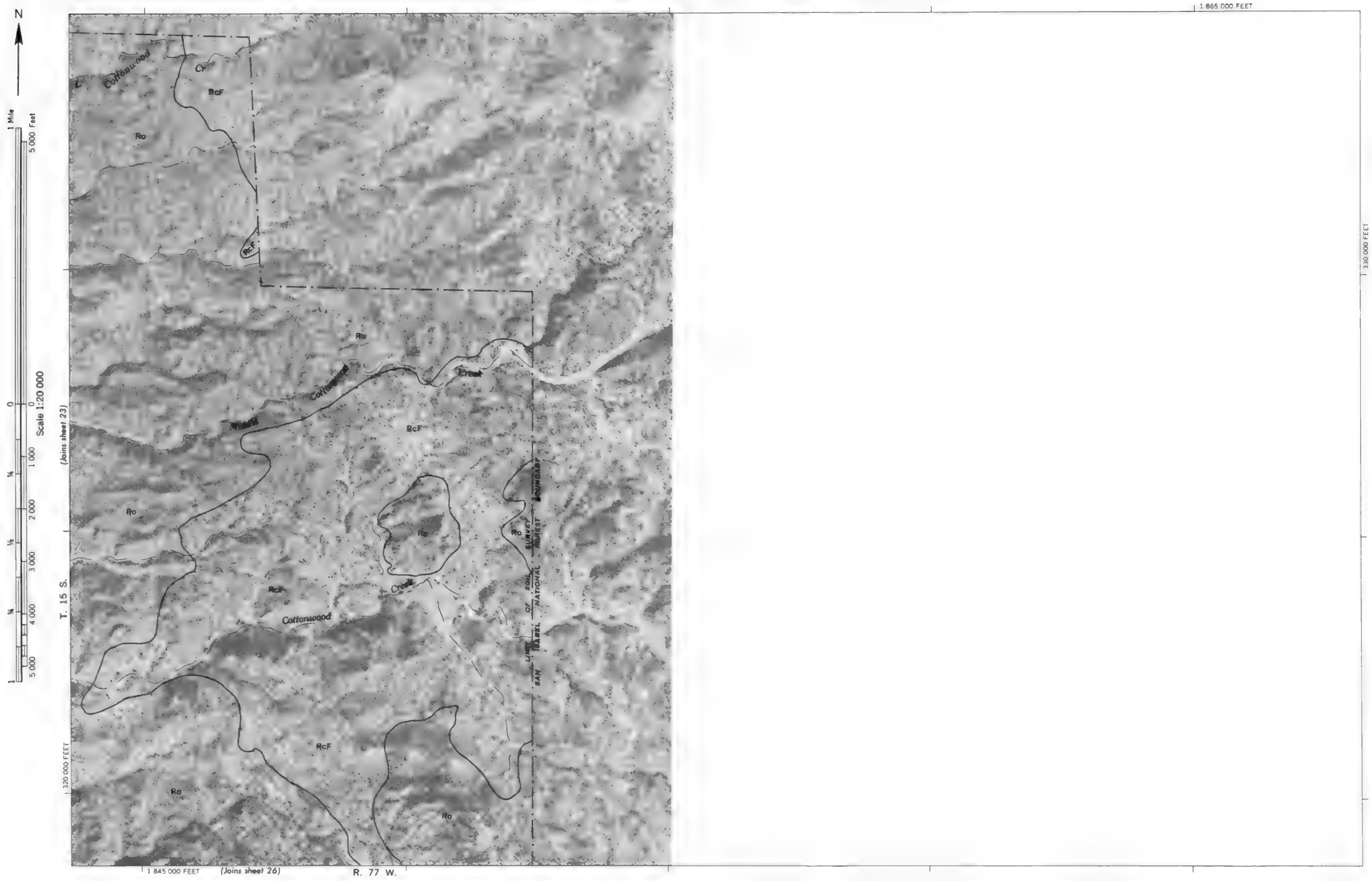
T. 15 S. | T. 14 S.

Land division corners are approximately positioned on this map.  
Photobase from 1956, 1957 and 1967 aerial photography 5,000 foot grid ticks are approximate and based on Colorado plane coordinate system, south zone 1927 North American datum.  
This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Colorado Agricultural Experiment Station.



This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Colorado Agricultural Experiment Station. Photobase from 1956, 1957 and 1967 aerial photography. 5,000-foot grid ticks are approximate and based on Colorado plane coordinate system. South zone 1927 North American datum. Land divisions on corners are approximately positioned on this map.





Photobase from 1956, 1957 and 1967 aerial photography. 5,000 foot grid ticks are approximate and based on Colorado plane coordinate system, south zone 1927 North American datum. This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Colorado Agricultural Experiment Station.

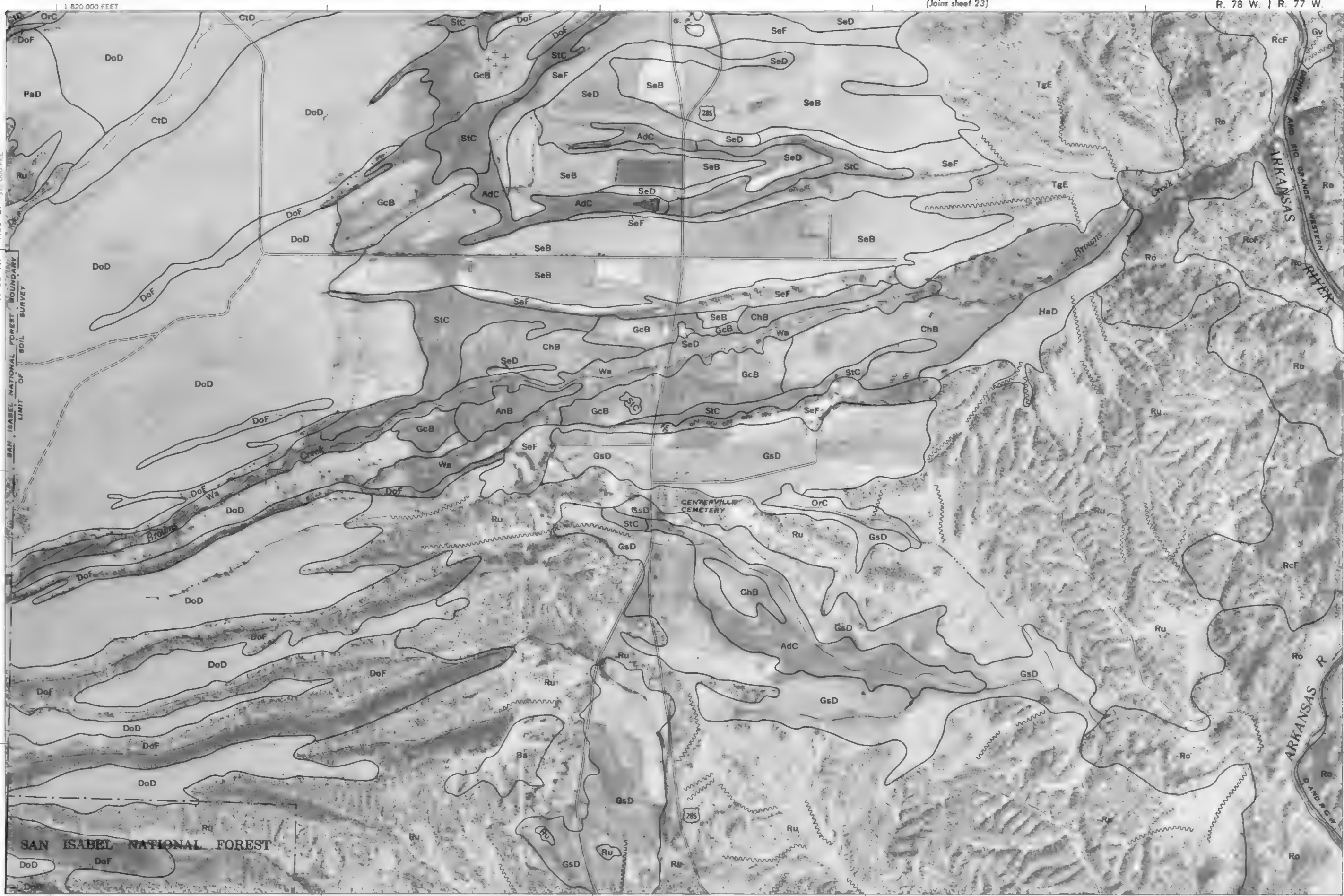
Land division corners are approximately positioned on this map.



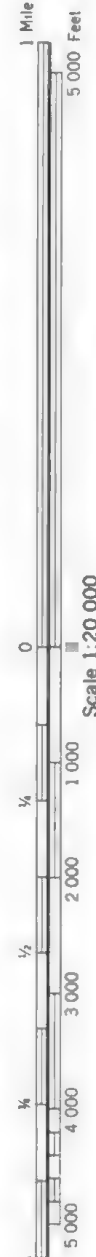
(Joins inset B, sheet 21)

T. 51 N. T. 15 S. 31° 00' 00" E.

SAN ISABEL NATIONAL FOREST  
BOUNDARY  
LIMIT OF  
SOIL SURVEY



(Joins inset A, sheet 26)

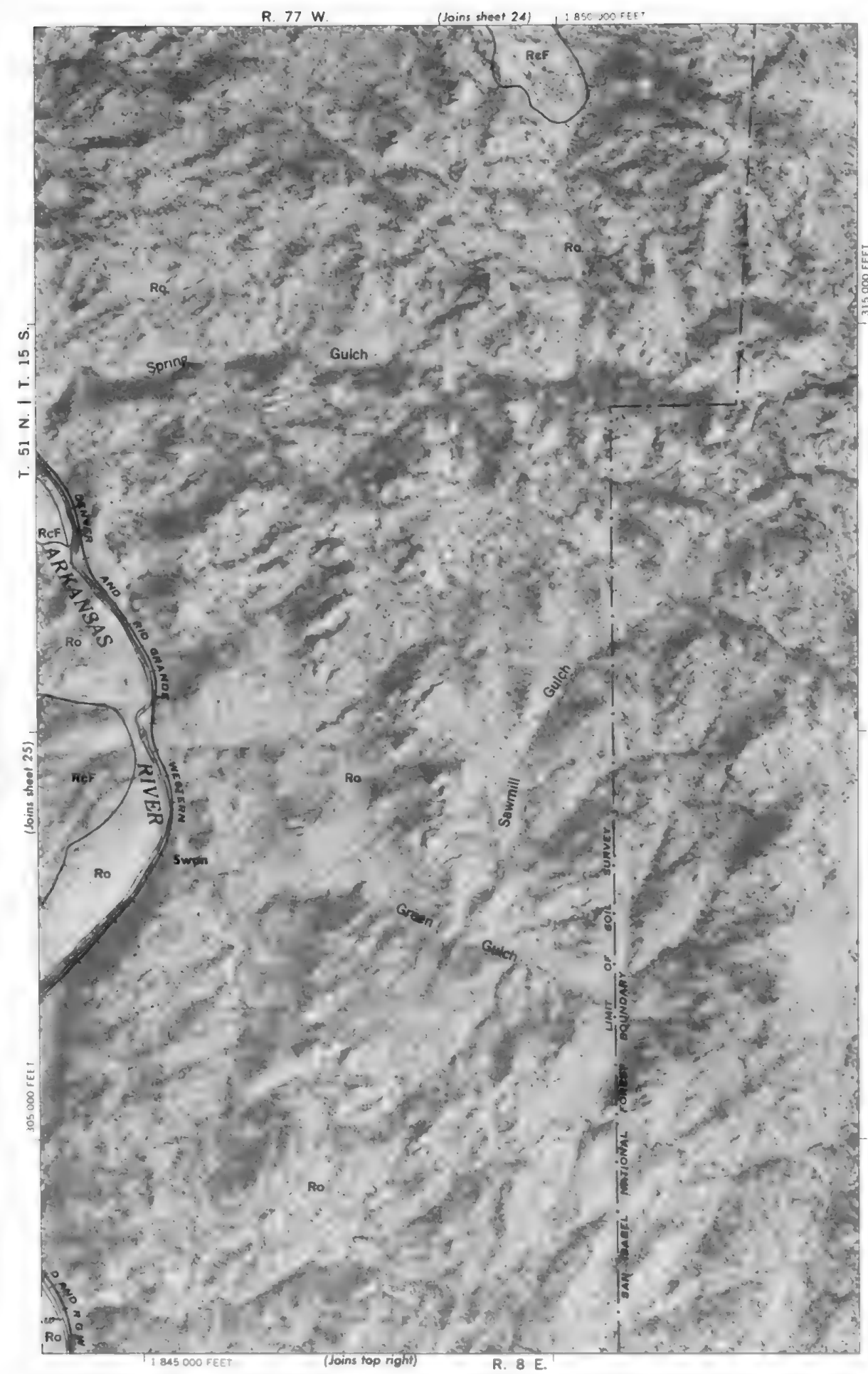
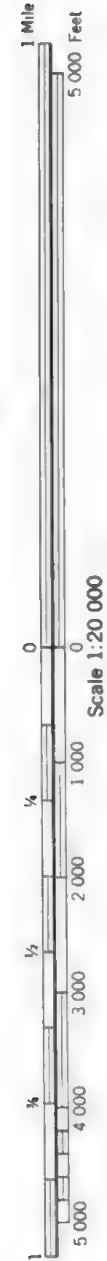


Scale 1:20 000

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Colorado Agricultural Experiment Station. Photobase from 1956, 1957, and 1961 aerial photography. 5,000 foot grid lines are approximate and based on Colorado plane coordinate system, south zone, 1927 North American datum. Land division corners are approximately positioned on this map.

R. 8 E.

(Joins sheet 27) 1 840 000 FEET





This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Colorado Agricultural Experiment Station. Photobase from 1956, 1957 and 1967 aerial photography. 5,000-foot grid ticks are approximate and based on Colorado plane coordinate system, south zone, 1927 North American datum. Lend division corners are approximately positioned on this map.



(inset 30) (Joins sheet 28)

R. 7 E. | R. 8 E.

(Joins sheet 28) 1 840 000 FEET

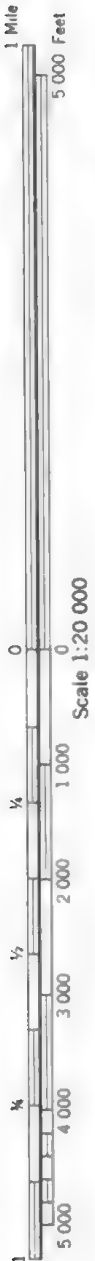
(Joins inset B, sheet 26)





R. 8 E.

(Joins sheet 27) 1 840 000 FEET



T. 50 N.  
(Joins inset, sheet 30)



1 820 000 FEET (Joins sheet 31)

(Joins sheet 29)

Land division corners are approximately positioned on this map.  
Photobase from 1956, 1957 and 1967 aerial photography. 5,000 foot grid ticks are approximate and based on Colorado plane coordinate system, south zone 1927 North American datum.  
This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Colorado Agricultural Experiment Station.

(Joins inset B, sheet 26)  
1:1845 000 FEET



This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Colorado Agricultural Experiment Station. Photobase from 1956, 1957 and 1967 aerial photography. 5,000 foot grid ticks are approximate and based on Colorado plane coordinate system, south zone, 1927 North American datum. Land division corners are approximately positioned on this map.

(Joins sheet 28)

(Joins sheet 32) 1:1865 000 FEET





Photobase from 1956, 1957 and 1967 aerial photography. 5,000 foot grid lines are approximate and based on Colorado plane coordinate system, south zone 1927 North American datum. This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Colorado Agricultural Experiment Station.







Scale 1:20 000

(Joins sheet 31)



1:845 000 FEET (Joins sheet 36)

(Joins sheet 33)

T. 49 N. | T. 50 N.

Land division corners are approximately positioned on this map. Photographs from 1946, 1957 and 1967 aerial photography, 5,000 foot grid ticks are approximate and based on Colorado plane, world date system, south zone 14, North American datum. This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service and the Colorado Agricultural Experiment Station.



1 870 000 FEET

INSET B

R. 9 E.

(Joins lower left inset A)

250 000 FEET

T. 49 N.

1 865 000 FEET

1 868 000 FEET

1 880 000 FEET

3 000 AND 2 000-FOOT GRID TICKS

INSET C

(Joins sheet 36)

1 865 000 FEET

1 868 000 FEET

235 000 FEET

T. 49 N. 237 000 FEET

R. 9 E.

3 000 AND 2 000-FOOT GRID TICKS

1 870 000 FEET

1 880 000 FEET

1 890 000 FEET

1 900 000 FEET

1 910 000 FEET

1 920 000 FEET

1 930 000 FEET

1 940 000 FEET

1 950 000 FEET

1 960 000 FEET

1 970 000 FEET

1 980 000 FEET

1 990 000 FEET

2 000 000 FEET

2 010 000 FEET

2 020 000 FEET

2 030 000 FEET

2 040 000 FEET

2 050 000 FEET

2 060 000 FEET

2 070 000 FEET

2 080 000 FEET

2 090 000 FEET

2 100 000 FEET

2 110 000 FEET

2 120 000 FEET

2 130 000 FEET

2 140 000 FEET

2 150 000 FEET

2 160 000 FEET

2 170 000 FEET

2 180 000 FEET

2 190 000 FEET

2 200 000 FEET

2 210 000 FEET

2 220 000 FEET

2 230 000 FEET

2 240 000 FEET

2 250 000 FEET

2 260 000 FEET

2 270 000 FEET

2 280 000 FEET

2 290 000 FEET

2 300 000 FEET

2 310 000 FEET

2 320 000 FEET

2 330 000 FEET

2 340 000 FEET

2 350 000 FEET

2 360 000 FEET

2 370 000 FEET

2 380 000 FEET

2 390 000 FEET

2 400 000 FEET

2 410 000 FEET

2 420 000 FEET

2 430 000 FEET

2 440 000 FEET

2 450 000 FEET

2 460 000 FEET

2 470 000 FEET

2 480 000 FEET

2 490 000 FEET

2 500 000 FEET

2 510 000 FEET

2 520 000 FEET

2 530 000 FEET

2 540 000 FEET

2 550 000 FEET

2 560 000 FEET

2 570 000 FEET

2 580 000 FEET

2 590 000 FEET

2 600 000 FEET

2 610 000 FEET

2 620 000 FEET

2 630 000 FEET

2 640 000 FEET

2 650 000 FEET

2 660 000 FEET

2 670 000 FEET

2 680 000 FEET

2 690 000 FEET

2 700 000 FEET

2 710 000 FEET

2 720 000 FEET

2 730 000 FEET

2 740 000 FEET

2 750 000 FEET

2 760 000 FEET

2 770 000 FEET

2 780 000 FEET

2 790 000 FEET

2 800 000 FEET

2 810 000 FEET

2 820 000 FEET

2 830 000 FEET

2 840 000 FEET

2 850 000 FEET

2 860 000 FEET

2 870 000 FEET

2 880 000 FEET

2 890 000 FEET

2 900 000 FEET

2 910 000 FEET

2 920 000 FEET

2 930 000 FEET

2 940 000 FEET

2 950 000 FEET

2 960 000 FEET

2 970 000 FEET

2 980 000 FEET

2 990 000 FEET

3 000 000 FEET

3 010 000 FEET

3 020 000 FEET

3 030 000 FEET

3 040 000 FEET

3 050 000 FEET

3 060 000 FEET

3 070 000 FEET

3 080 000 FEET

3 090 000 FEET

3 100 000 FEET

3 110 000 FEET

3 120 000 FEET

3 130 000 FEET

3 140 000 FEET

3 150 000 FEET

3 160 000 FEET

3 170 000 FEET

3 180 000 FEET

3 190 000 FEET

3 200 000 FEET

3 210 000 FEET

3 220 000 FEET

3 230 000 FEET

3 240 000 FEET

3 250 000 FEET

3 260 000 FEET

3 270 000 FEET

3 280 000 FEET

3 290 000 FEET

3 300 000 FEET

3 310 000 FEET

3 320 000 FEET

3 330 000 FEET

3 340 000 FEET

3 350 000 FEET

3 360 000 FEET

3 370 000 FEET

3 380 000 FEET

3 390 000 FEET

3 400 000 FEET

3 410 000 FEET

3 420 000 FEET

3 430 000 FEET

3 440 000 FEET

3 450 000 FEET

3 460 000 FEET

3 470 000 FEET

3 480 000 FEET

3 490 000 FEET

3 500 000 FEET

3 510 000 FEET

3 520 000 FEET

3 530 000 FEET

3 540 000 FEET

3 550 000 FEET

3 560 000 FEET

3 570 000 FEET

3 580 000 FEET

3 590 000 FEET

3 600 000 FEET

3 610 000 FEET

3 620 000 FEET

3 630 000 FEET

3 640 000 FEET

3 650 000 FEET

3 660 000 FEET

3 670 000 FEET

3 680 000 FEET

3 690 000 FEET

3 700 000 FEET

3 710 000 FEET

3 720 000 FEET

3 730 000 FEET

3 740 000 FEET

3 750 000 FEET

3 760 000 FEET

3 770 000 FEET

3 780 000 FEET

3 790 000 FEET

3 800 000 FEET

3 810 000 FEET

3 820 000 FEET

3 830 000 FEET

3 840 000 FEET

3 850 000 FEET

3 860 000 FEET

3 870 000 FEET

3 880 000 FEET

3 890 000 FEET

3 900 000 FEET

3 910 000 FEET

3 920 000 FEET

3 930 000 FEET

3 940 000 FEET

3 950 000 FEET

3 960 000 FEET

3 970 000 FEET

3 980 000 FEET

3 990 000 FEET

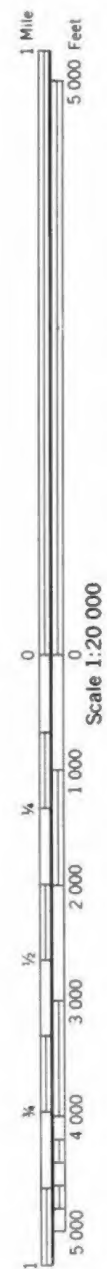
4 000 000 FEET

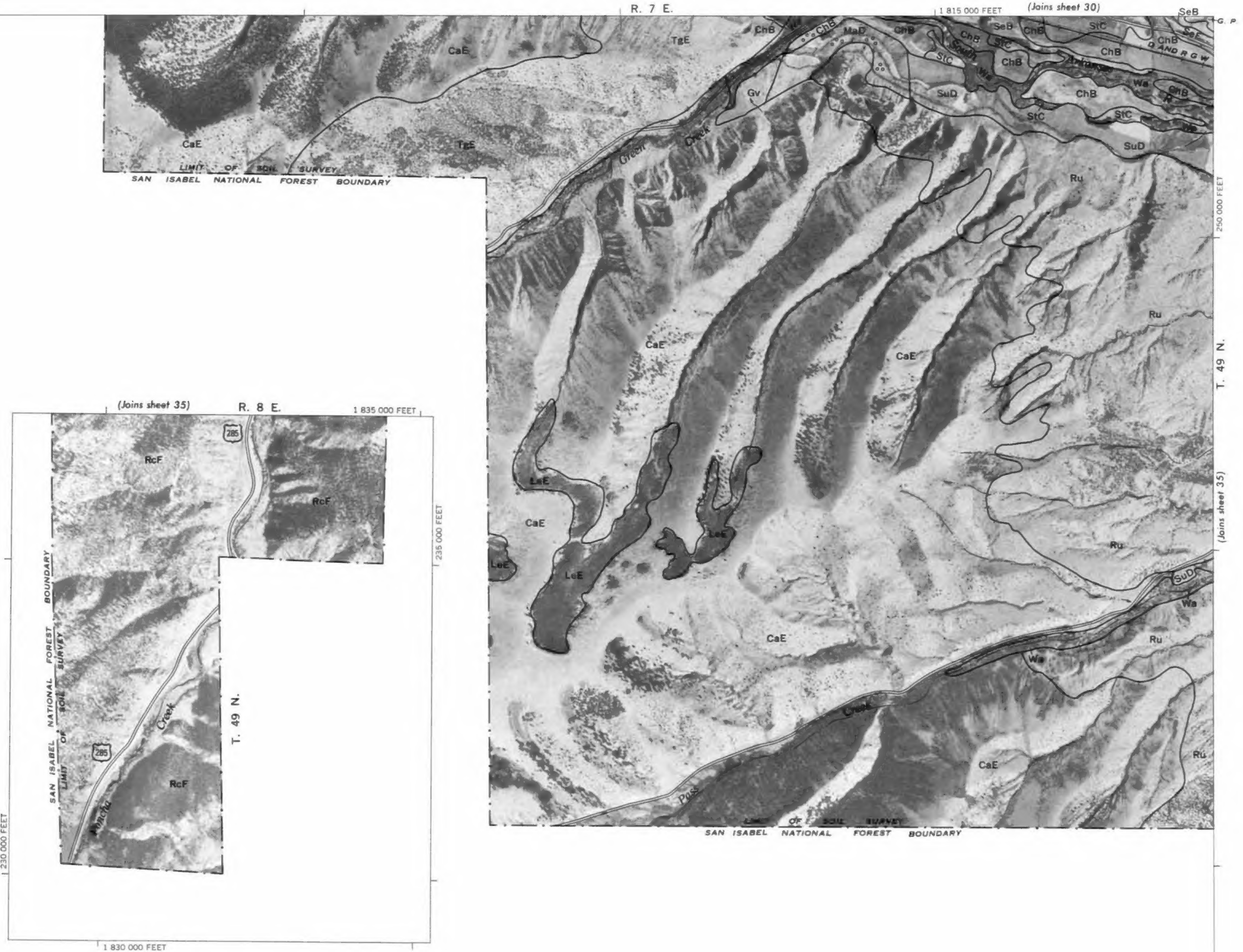
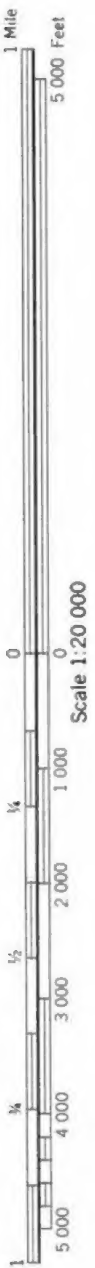
4 010 000 FEET

4 020 000 FEET

4 030 000 FEET

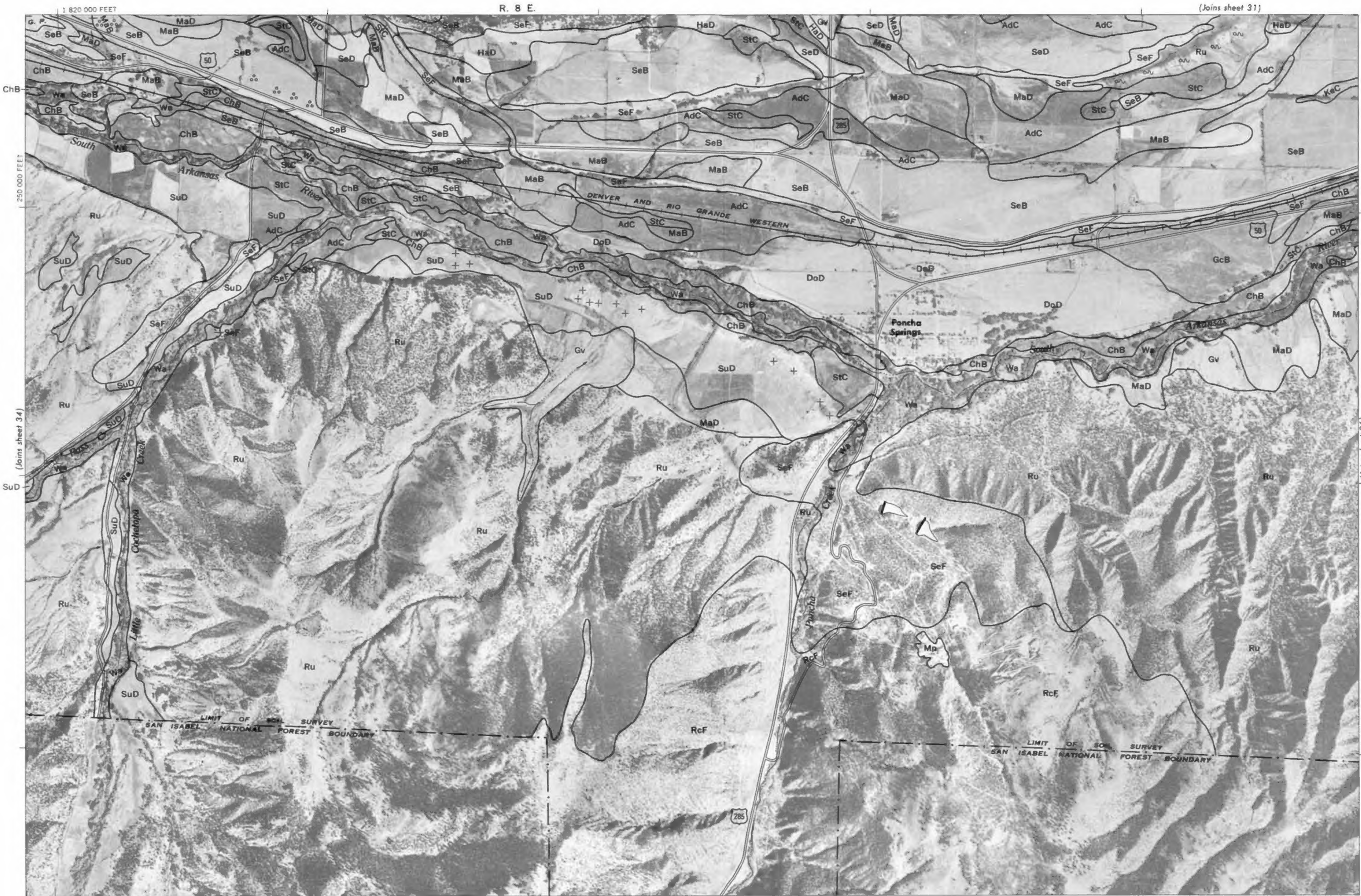
4 040 000 FEET





Land division corners are approximately positioned on this map.  
Photobase from 1956, 1957 and 1967 aerial photography. 5,000 foot grid ticks are approximate and based on Colorado plane coordinate system, south zone, 1927 North American datum.  
This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Colorado Agricultural Experiment Station.





This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Colorado Agricultural Experiment Station. Photobase from 1956, 1957 and 1967 aerial photography. 5,000-foot grid ticks are approximate and based on Colorado plane coordinate system, south zone, 1927 North American datum. Land division corners are approximately positioned on this map.

(Joins inset, sheet 34)

(Joins sheet 36)

(Joins sheet 31)

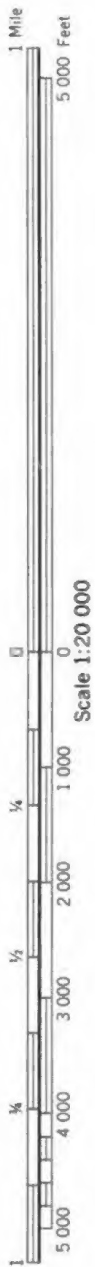
(Joins sheet 34)

1 840 000 FEET

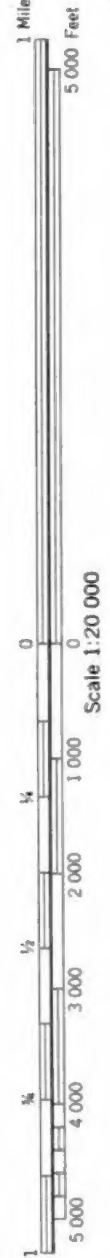
1 820 000 FEET

R. 8 E.

T. 49 N.







(Joins sheet 35)

(Joins inset B, sheet 33)

(Joins inset C, sheet 33)

Land division corners are approximately positioned on this map. Photobase from 1956, 1957 and 1967 aerial photography. 5,000-foot grid ticks are approximate and based on Colorado plane coordinate system, south zone, 1927 North American datum. This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Colorado Agricultural Experiment Station.